ISSN 2226-2865

Hong Kong Entomological Bulletin

Volume 4 (1) April 2012

Hong Kong Entomological Bulletin

The Journal of the Hong Kong Entomological Society

Volume 4 (1) April 2012

Contents

Cover photograph: *Zethus* sp. female constructing nest entrance tunnel (photo by Christophe Barthélémy)

The Hong Kong Entomological Bulletin publishes papers reporting on all aspects of Insecta in Hong Kong and the wider bioregion, including biology, behaviour, ecology, systematics, taxonomy, genetics and morphology. Papers can be original research results, reviews or short communications. There is no page limit to the manuscripts and no page charge will be applied. *At the editors' discretion, an independent review of submitted manuscripts will be sought from an appropriate authority.*

Guidelines for authors: http://hkentsoc.org/publications/guidelines/content.html

 http://hkentsoc.org

Nest Trapping, a simple method for gathering information on life histories of solitary bees and wasps. Bionomics of 21 species of solitary aculeate in Hong Kong.

Christophe Barthélémy
Sai Kung, Hong Kong,
E-mail: chb99@netvigator.com; Tel: +852 23282636

Abstract

The nesting behaviour of 21 species of solitary wasps and bees, belonging to the families Sphecidae, Crabronidae, Pompilidae, Vespidae, Megachilidae and Colletidae using trap nests is presented. I provide information on nest architecture and biologies of the described species, including, brood development, mortality, parasites and associates.

Key words: Nest traps, solitary Aculeata, nest architecture, life history, prey, associates, brood death.

Introduction

Many solitary Aculeata build their nests in concealed locations, whether borrowers, tube renters, or nest builders. In consequence it is often difficult if not impossible to obtain precise data regarding their nesting biology. The use of nest traps alleviates this problem and comprehensive information with regards to life histories of some solitary bees and wasps can be documented easily.

The traps that are discussed in this paper are only applicable to those solitary Aculeata that use pre-existing cavities, generally those produced by wood boring larvae of Coleoptera, called tube renters, in that they do not construct the substratum of their nest, only fashioning cells with partitions of various materials in pre-existing linear cavities. Whilst the technique is restrictive, the number of species caught remains important.

The method has been employed with great success since Karl Krombein rationalised the process in the mid 1950. His experiments led to the publication in 1967 of a seminal book, *Trap-Nesting Wasps and Bees: Life Histories, Nests and Associates* (Krombein 1967), which has been the model for such studies since then. While Krombein standardised his traps by using blocks of wood with fixed bores holes (length and diameter), thus controlling some of the variables in the nesting process, I used a less sophisticated method consisting of cut bamboo canes to conduct the experimentation.

Methods

Trap construction and placing

The selection of the bamboo canes was of the upmost importance. They were of various diameters but with internodes greater than 150mm, and with a hollow centre (some bamboos have pith in their cores), with walls sufficiently thick (ideally 2-3mm) to avoid water penetration during the rainy season.
The canes were harvested either dead or green, but if green they were dried thoroughly to avoid formation of mould during the wet season.
When dry, the canes were cut into segments of minimum 150mm length, so that one end was closed by a nodal septum, leaving the other end open. For standardisation purposes all segments were cut to the same length.
Each segments represented one trap and was given a unique number, its maximum diameter and internal length measured using callipers and the data logged into an Excel spread sheet. Once this was done, the segments were bundled together; seven segments forming a near circular bundle; with sheathed wire, one roll at each end of the bundle, preferably assembling traps of similar diameter and internal length.
The locations varied but traps were placed in shaded or semi-shaded conditions to avoid overheating of the brood during hot sunny days, and the locations were recorded (orientation and height from the ground) in the same spreadsheet.
Traps were fixed to branches or other supports using the extra length of the sheathed wire and placed in a slightly oblique fashion to avoid water penetration inside the trap during rain. See **Figure 1**.

Rearing and data collecting

During the activity period of wasps and bees (from April to October in Hong Kong), traps were inspected regularly to detect if any occupation had occurred. When a trap showed the presence of a nest it was collected for dissection. To ascertain the development time and growth of brood, some traps were collected as soon as the nest was completed so that the brood could be observed from egg to emergence of adult. Others were left *in-situ* for a longer period of time so that parasites that use mature larvae or pupae were given a chance to attack the concerned nest. Having said that, cleptoparasites (mainly flies) gain access to the nest when the wasp or bee is

constructing it, therefore early collection still yielded data regarding brood development and parasitism.

When collected, I gently splited the bamboo segment with a pen knife, making sure no cell content was damaged in the process. The split trap was placed on a white sheet of paper next to a ruler and photographed, with a Nikon D200 digital camera, 60mm Nikkor mircro-lens and Sunpak DX12R ring flash. I generally photographed the entire nest and also took detail pictures of each cells within.

The content of the trap was recorded in a database that contained the following fields:

- Location.
- Coordinates (UTM and/or longitude/latitude).
- Altitude.
- Sub-location: a short description of the environment using key words.
- Trap Number (obtained at trap fabrication).
- Orientation (obtained at placement of trap).
- Height from the ground (obtained at placement of trap).
- Date set (obtained at placement of trap).
- Date collected.
- Maximum diameter (obtained at trap fabrication).
- Maximum length (obtained at trap fabrication).
- Number of cells.
- Length of each cells.
- Fields concerning the nest architecture. See **Figure 2** for terminology.
- Prey description (Order, family, genus and species)
- Number of prey per cells and prey development stage.
- Brood description at opening (egg, larva, pupa).
- Parasites/associates description (Order, family, genus and species).
- Wasp description (Order, family, genus and species).
- Number of females emerging (obtained a brood emergence).
- Number of males emerging (obtained at brood emergence).
- Notes: description of observations beyond the fields above, such as brood behaviour, parasite/associate behaviour, emergence date, detailed descriptions of the cell partition construction, etc.

When the content had been recorded the trap was reassembled using masking tape (for ease of re-opening when observing the development of brood and parasites/associates) wrapped around the segment at each end and then placed in a Ziplock® bag to avoid later contamination by parasites. This is a real problem in a laboratory as species of *Melittobia* (Eulophidae) can infest entire nests and nest collections. They are difficult to spot due to their minute size and reproduce in very large numbers. If the traps were collected on or just after rain it was essential to thoroughly dry them as mould will develop quickly in the confines of the bag, which would eventually destroy brood and nest content.

The bags were suspended on a made-to-purpose rack or in an aquarium. An aquarium with a lid was preferred since many bees and wasps are able to chew their way out of the Ziplock® bags, which voids essential data such as emergence date or sex of adults and sex ratio.

A very small invasive ant, *Monomorium floricola* (Jerdon, 1851) (Myrmicinae) is also a major pest for nest collections as they are able to enter the Ziplock® bags, either by perforating them or by penetrating through the tiny gap left on the zipper next to the slider. They will destroy the entire content of the nest, breed there and assault nearby bags. To alleviate this, all storing elements were placed in trays with water.

When all this was done, each individual trap could be re-opened at leisure to observe development of brood and parasites/associates. Photographic recording of the intermediary stages was deemed advisable as sometime details may have escaped my preliminary observations.

Results

I have used such traps since 2006, placing 957 of them in Hong Kong, mainly in my garden at Pak Sha O, Sai Kung Country Park (22.25'N- 114.19'E. UTM: 50Q KK 242 849, 70m asl). I present here data on 326 nests, the remaining 650+ representing those that were never collected (due to misplacement or never being occupied), those that were occupied by various species of ants, those that I collected after emergence of adults and for which no detailed data were obtained, those still in the field waiting for an occupant as well as those in the process of rearing at the time of writing this paper.

The 326 successful nests comprised 824 cells and yielded data for 21 different species of solitary bees and wasps in six families, Colletidae, Megachilidae, Crabronidae, Sphecidae, Pompilidae and Vespidae. Refer to **Tables 1 & 2** for a summary of the trap data.

In this study I do not report in detail occupation of traps by various species of ants, most commonly I found:

- *Camponotus nicobarensis* Mayr, 1865 (Formicinae).
- *Camponotus sp* (Formicinae).
- *Polyrhachis demangei* Santschi, 1910 (Formicinae).
- Two to three species of *Crematogaster* spp. (Myrmicinae).
- *Monomorium floricola* (Jerdon, 1851) (Myrmicinae).

Tube Renting Solitary Aculeata

Family Crabronidae, Subfamily Crabroninae

Trypoxylon formosicola Strand, 1922

I reared this species (**Figure 3**) from five traps totalling 21 cells. The traps had borings of 4-6.7mm (mean 5mm, *n* = 4) in diameter and length of 165-195mm (mean 171mm, *n* = 4). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in May 2009 and May 2010. **Figure 4** shows the typical content of a nest at opening.

Nest architecture
The wasp constructed 2-6 cells per nest (mean 4.2, *n* = 5). The cell partitions were constructed from mud and sand and were1.4-4.3mm thick. All but one nest had a preliminary and nest plug of the same material. Two nests had intercalary cells presumed to be abortive cells. Cell 1 was 24-53mm long (mean 35.25mm, *n*= 4), cell 2 was 12-33mm long (mean 27.7mm, *n* = 4), cell 3 was 23-36mm long (mean 30mm, *n* = 4), Cell 4 was 17-27mm long (mean 21.7mm, *n* = 4), cell 5 was 22-25mm (mean 23.5mm, *n* = 2) and cell 6 was 19mm long (*n* = 1).

Prey
Each cell was mass-provisioned with spiders in the Araneidae family and the wasp provisioned 3-7 items (mean = 4.7, *n* = 3) per cell. In one trap I was able to determine the species as follows: *Araneus viridiventris* Yaginuma, 1969 , *Araneus spp*, possibly *Eriovixia poonaensis* (Tikader & Bal, 1981) and *Nephila pilipes* (Fabricius) 1793, most were immatures (*Nephila* sp.) and some were males. The prey were generally lightly paralysed and were able to move their limbs.

Life history
I was able to collect only limited data on the development stage of the brood. It appears that the larvae took 4-6 days to complete feeding and 15-20 days to complete metamorphosis and emerge as adults. The mature larvae spun a single layered cocoon in 1-3 days creamy in colour and suspended from taught strands of silk fixed to the cell walls. **Figures 5 & 6** show a mature larva and a cocoon respectively.
There was an overwhelming female bias with 12 females emerging to two males (6:1).
As I only collected this species early in the season, I was unable to ascertain the number of generations per year. But considering the short development period of 20-25 days from egg to emergence of adult it can be inferred that this species is multi-voltine in Hong Kong.

Natural enemies, associates and brood death
Of the five nests collected with this species none had been parasitised, however a total of four brood died during development (19%) from unknown reasons.

Identification
The species identification was carried out by Alexander Andropov, Senior Scientist and Curator of Hymenoptera collections Zoological Museum of Moscow State University, Moscow, Russia and the prey were identified by Dickson Wong, Hong Kong.

Trypoxylon petiolatum Smith, 1858

I reared this species (**Figure 7**) from 18 traps totalling 93 cells. The traps had borings of 3.4-10.5mm (mean 7.1, *n* = 17) in diameter and length of 155-225mm (mean 181.4, *n* = 17). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in May 2009, July 2010, April, June and August 2011. See Barthélémy (2010a) for a detailed account of the biology of this species. **Figure 8** shows the typical content of a nest at opening.

Nest architecture.
The wasp constructed 2-8 cells per nest (mean 5.5, *n* = 18). The cells were separated by cemented partitions, convex and smooth towards the entrance, irregular posteriorly. The partitions were composed of mixed material (sand grains, clay and possibly organic material) 1-3.5mm thick. The nest plug was composed of the same material but applied in a much thicker layer. As a rule the nests had the following characteristics:

- each nest had a vestibular cell defined by the last cell partition and the nest plug,
- nests could be constructed with or without preliminary plug (eight nests had no preliminary plug and 10 had one), and
- no empty intercalary cells were present.

Cell 1 was 17-44mm long (mean 22mm, *n* = 16), cell 2 was 11-27mm long (mean 18.2mm, n = 16), cell 3 was 11-30mm long (mean 18.9mm, *n* = 15), cell 4 was 14-55mm long (mean 23mm, *n* = 15), cell 5 was 18-23mm long (mean 20.6mm, *n* = 12), cell 6 was 7-26mm (mean 17.7mm, *n* = 6), cell 7 was 16-22mm long (mean 18.2mm, *n* = 5) and cell 8 was 18-19mm long (mean 18.5mm, *n* = 2).

Prey
Each cell was mass-provisioned with 2-8 small spiders (mean = 3.9, *n* = 44). An overwhelming majority were in the Salticidae family, but specimens from the Oxypodidae family were also present. On four nests I was able to ascertain the exact content of each cell as summarised in **Table 3** of Barthélémy (2010a). All prey were lightly paralysed and able to move their appendages and spin some silk. **Figure 9** shows the typical prey content of one nest.

Life history
The brood development time is reported here as detailed in Barthélémy (2010a). The egg hatched in approximately two days and it took five days for the larva to complete feeding. The pupal stage lasted 18 days, giving a total

development time of 23 days. The eggs were laid latero-ventrally on the abdomen of the prey, attached anally close to the cephalothoracic-abdominal junction (**Figure 10**). From observations at trap opening, it appears likely that the eggs were laid on the last prey item brought into each cell.

The mature larva spun a single layer cream-coloured cocoon suspended to taught strands of silk fixed to the cell walls, contrary to what I reported in my initial paper (Barthélémy 2010a).

The sex ratio was nearly 2:1 females to males (29 emerged females for 16 males).

I was not able to determine with confidence the number of generations per year of this crabronid but nests were initiated continuously from April to August suggesting that this species is multi-voltine in Hong Kong with at least four viable generations per year. Recent observations show that this species was still active in November 2011, much later than was previously assumed (Barthélémy 2010a). **Figures 11 & 12** show a mature larva and a cocoon respectively.

Natural enemies, associates and brood death

Out of 71 active brood at opening eight were parasitised. Five cells in one nest had been attacked by *Melittobia sp* (Eulophidae) and one cell in two nests was parasitised by an unidentified dipteran (a cleptoparasite). Minute mites were found on a mature brood of one nest. Additionally a total of 36 brood died for reasons not associated with parasitism which corresponding to approximately 50% of all active cells. If combined with parasitism, brood death during development totals 72%.

Other observations

Cases of cannibalism were observed when a larva was able to enter in contact with another in an adjacent cell (after the partition had been damaged at trap opening).

Identification

Trypoxylon petiolatum was identified by Alexander Andropov, Senior Scientist and Curator of Hymenoptera collections Zoological Museum of Moscow State University, Moscow, Russia. The eulophid parasite was identified by the author and the prey were identified by Dickson Wong, Hong Kong.

Family Sphecidae, Subfamily Sphecinae

Isodontia aurifrons (Smith, 1859)

I reared this sphecid from eight traps totalling 10 cells. The traps had borings of 10.5-13mm (mean = 11.8mm, *n* = 8) in diameter and were 165-200mm long (mean = 179mm, *n* = 8). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in June 2009, May 2010, June and July 2011. **Figure 24** shows the typical content of a nest at opening.

Nest architecture

Isodontia aurifrons constructed 1-2 cells per nest (mean = 1.25, *n* = 8). The architecture was very similar to that of *I. nigella*, the cell partitions being loosely compacted dry grass material. There was no preliminary plug and the nest plug was identical to that of *I. nigella*. No intercalary or vestibular cells were recorded.

Cell 1 was 23-48mm long (mean = 33.3mm, *n* = 6) and cell 2 was 30-35mm long (mean = 32.5mm, *n* = 2).

Prey

Each cell was mass-provisioned with 3-7 immature Orthoptera (mean = 5, *n* = 7). I was able to identify 10 prey in two nests as *Xiphidiopsis* sp (Tettigoniidae, Meconematinae) others were in the Gryllidae family. Prey were lightly paralysed, able to move appendages and defecate. **Figure 25** shows the typical prey content of a nest.

Life history

From limited data it appears that the egg is laid on the first prey item close to the cephalo-thoracic junction (**Figure 26**). It took 5-6 days for the larva to complete feeding and another 25-27 days to complete metamorphosis and emerge from the nest. In several instances I found two eggs in one cell, although in all cases either one brood or both died during development. The larva spun a single layered cocoon of whitish silk slightly adherent to the cell walls. **Figures 27 & 28** show a mature larva and a cocoon respectively. Two females emerged from the only two viable cells that I reared.

Natural enemies, associates and brood death

This sphecid is victim to high rate of parasitism and four out of 10 cells were parasitised by phorid flies (cleptoparasites) and *Melittobia* sp. (Eulophidae), a total of 40%. In another four cells (40%) the brood died for reasons not associated to parasitism, for a total of 80% of brood mortality. One emerging specimen was found to be heavily stylopised.

Identification

Isodontia aurifrons was identified Dr. Michael Ohl, Museum fuer Naturkunde, Berlin, Germany. The phorid cleptoparasites and the eulophid parasites were identified by the author and the prey were identified by Dr David Ragge, Natural History Museum, London, United Kingdom.

Isodontia diodon (Kohl, 1890)

I reared this species (**Figure 13**) from 42 traps containing 114 cells. The traps had borings of 4.5-14mm (mean 8.1mm, *n* = 42) in diameter and length of 143-225mm (mean 175.5mm, *n* = 42). They were placed in two localities, my garden (Pak Sha O, Sai Kung Country Park) and Ha Tin Liu Ha (New Territories, UTM: 50Q KK 058 849, 60m asl). Traps were collected from May to October 2009, from April to September 2010 and from May to September 2011. See

Barthélémy (2010b) for a detailed account of the biology of this species. **Figure 14** shows the typical content of a nest at opening.

Nest architecture

This sphecid constructed 1-6 cells per nest (mean 2.7, *n* = 42). The cells were separated by loosely compacted plant hair material that was procured from three different plant sources, namely *Mallotus paniculatus* Muell. Arg (Euphorbiaceae), *Vitis balanseana* Planch, 1887 (Vitaceae) and *Bohemeria nivea* (L.) Gaudich. (Urticaceae). The nest plug was constructed with the same material but tightly compressed and was 15-25mm long finished flush with the trap entrance.

Nests could be characterized by the following:

- they had no vestibular or intercalary cells,
- the outer end of the most external cell was always defined by the nest plug,
- the innermost cells did not necessarily start from the bottom of the tube, but could be initiated anywhere along its length, and
- the inner end of the first cell was always padded with cell partition material (preliminary plug).

Cell 1 measured 15-155mm long (mean 45.4mm, *n* = 24), cell 2 was 10-177mm long (mean 48.7mm, *n* = 22), cell 3 was 17-85mm long (mean 36.6mm, *n* = 16), cell 4 was 16-80mm long (mean 33.6mm, *n* = 9), cell 5 was 20-56mm long (mean 58mm, *n* = 3), and cell 6 was 125mm long (*n* = 1).

Prey

Each cell was mass-provisioned with 3-9 (mean 6, *n* = 66) specimens of Blatellidae, with matures much more common than nymphs. A sampling of nine nests found that the majority of the prey (60.6%) were *Balta* sp1, 32% were adults (males and females) of *Blatella bisignata* (Brunner von Wattenwyl, 1893) and a little over 7% were small unidentified Blatellidae in different species. The prey were packed head first and lightly paralysed, able to move appendage and defecate. In several instances the prey had deposited an ootheca from which emerged nymphs. **Figure 15** shows the typical prey content of one nest.

Isodontia diodon has a very specialised diet and only one other species, *I. formosicola* (Strand 1913) is known to provision Blatellidae (Bohart & Menke 1976), the genus generally preying upon Orthoptera.

Life history

Eggs were laid latero-ventrally on the first prey, the anal end attached close to the fore or mid coxae joints (**Figure 16**). They hatched in 2-3 days (mean = 2.1, *n* = 18), while the development time from oviposition to pre-pupal larva was 5-7 days (mean = 6.2, *n* = 14). The pupation period lasted approximately 24-29 days from oviposition (mean = 25.9, *n* = 13) (Barthélémy 2010b). **Figures 17 & 18** show a mature larva and a cocoon respectively.

The pre-pupating larva spun a complete double-layered cocoon, slightly adherent to the cell walls, only attached by a few strands of silk in approximately one day; in the process, the cell partition material as well as prey remnants were used to cover the outer layer, making it difficult at times to distinguish the limits of the original cell. The whitish outer layer was coarsely woven and flexible, but resistant to shear. The inner layer was finely woven, more rigid, brittle and brownish (Barthélémy 2010b).

There was a sex ratio of nearly 2:1 females to males (43 females, 26 males).

I previously reported (Barthélémy 2010b) that this species had three generations per year, however recent data suggest that *I. diodon* may in fact have up to four generations per year. Indeed, I have reared from one nest individuals that emerged in April adding nearly two months to my earlier observations of the activity period of this sphecid. Additionally in 2011 I observed this species initiate new nests in early November.

Natural enemies, associates and brood death

While my earlier observations dealt with a few parasites/enemies, I have since gathered further data and new enemies have been observed. Two traps were infested by maggots of *Amobia quatei* Kurahashi (Diptera, Sarcophagidae, Miltogramminae), a subfamily commonly associated with cleptoparasitism in many solitary aculeate wasps (Krombein 1967, 1991; Evans and Eberhardt 1970; O'Neill 2001) and another five by maggots of *Megaselia* sp. (Diptera, Phoridae). Beyond flies I also recorded in one trap parasitism by a cryptine wasp, *Hadrocryptus perforator* Broad & Barthélémy 2011 (Ichneumondiae, Cryptinae) and in two nests parasitism by an unidentified Leucospidae. One adult *I. diodon* that had just emerged was found to be stylopised and a number of nests contained small mites. Instances of parasitism totalled 30.5% of all active brood while brood death during development for reasons not associated with parasitism was 18.3%, for a total brood mortality (all factors combined) of 48.8%.

Identification

Isodontia diodon was identified by Wojciech J. Pulawski, Curator, California Academy of Science, San Francisco, USA. *Amobia quatei* was identified by Liekele Sijstermans, University of Amsterdam, Netherlands. *Megaselia* sp. was identified by Paul Beuk, Natural History Museum of Maastricht, Netherlands. *Hadrocryptus perforator* was identified and named by Gavin Broad, Senior Curator (Hymenoptera), Department of Entomology, The Natural History Museum, London, United Kingdom and the prey species were identified by Darren Mann, Assistant Curator, Hope Entomological Collection, Oxford University, United Kingdom.

Isodontia nigella (F. Smith, 1856)

I reared this species (**Figure 19**) from six nests, totalling 13 cells. The traps had borings of 8-13mm (mean = 10.7mm, *n* = 6) in diameter and were 165-250mm (mean = 241.5mm, *n* = 6) long. They were placed in two localities, my garden (Pak Sha O, Sai Kung Country Park) and Wong Chuk Yeung (New Territories, UTM: 50Q KK 185 810, 200masl). Traps were collected in April and June 2009 and in May 2010. **Figure 20** shows the typical content of a nest at opening.

Nest architecture
This sphecid constructed 1-3 cells (mean = 2, *n* = 4) per nest. The cells were separated by loosely compacted dry grass material (grass blades and grass frass). There was no preliminary plug and the nest plug was a complex construction, starting posteriorly with a plug of finely chopped and heavily compacted dry grass material 15-20mm thick, followed by a semi-compacted assemblage of folded green grass blades and terminated by loose blades of dry grass. There were no intercalary or vestibular cells.
Cell 1 was 20-125mm long (mean = 73.7mm, *n* = 4), cell 2 was 17-40mm long (mean = 30.7mm, *n* = 3) and cell 3 was 22mm long (*n* =1).

Prey
Each cell was mass-provisioned with 5-10 prey item (mean = 7.7, *n* = 4) composed of immatures of various species of Orthoptera, mainly in Acrididae, Tettigonidae and Gryllidae. **Figure 21** shows the prey content of one nest.

Life history
From partial information it seems that the egg is laid on the first prey laterally near the cephalo-thoracic junction. It took 25-30 days for the brood to complete development and emerge. In one cell I found two brood, one dead egg and a live larva. The mature larva spun a double layered cocoon, the outer layer very thin, loosely woven , white and comprising amalgamated bits of material and prey debris, while the inner layer was densely woven, rigid and brown. **Figure 22** shows a cocoon.
I obtained a male-biased sex ratio of 3:1 male to female.

Natural enemies, associates and brood death
Two cells out of 13 (15.4%) had been parasitised by *Melittobia* sp. (Eulophidae) and three emerging individuals were heavily stylopised. Minute mites were recorded in one nest and three (23%) brood died during development for reasons not associated with parasitism. The total brood death (all factors combined) was 38.4%.

Identification
Isodontia nigella and the eulophid parasite were identified by the author.

Family Sphecidae, Subfamily Sceliphrinae

Chalybion japonicum (Gribodo, 1883)

I reared this species (**Figure 29**) from 66 nests totalling 114 cells. The traps had borings of 6-10.5mm in diameter (mean = 7.5mm, *n* = 66) and were 155-230mm long (mean = 173mm, *n* = 66). All traps were placed in my office (Pak Sha O, Sai Kung Country Park) and collected in May, June, July 2010 and April 2011. See Barthélémy (2011) for detailed report on the biology of this mud-dauber.

Nest architecture
Chalybion japonicum was extremely versatile with regards to nesting site selection. Beyond the frequent usage of my obvious traps, the wasp selected any site that would present itself with a more or less tubular shape, whether it be the screw recesses in electrical appliances, cells of a nest of *Polistes gigas*, left on a table top, the cells constructed by *Sceliphron deforme* Smith 1856 (Sceliphrinae) the previous year or even interstices between rafters and joists of the roof. It was also observed to open fresh *S. deforme* cells, empty the content, prey and brood alike and then furnish them with its own prey and brood. It constructed 1-4 cells per nest (mean = 1.8, *n* = 66), but in fact each nest contained few cells, 40.9% of all nest contained 1 cell, 42.4% had 2 cells, 13.6% had 3 cells and 3.1% had 4 cells (Barthélémy 2011).
Cell were fashioned from a clayish material with inclusions of sand grains. In all cases the posterior side of the cell partitions had a rough finish while the anterior surface was smooth. A great variety of forms of closures was observed, from a simple clay partition maximum 3mm thick, with or without adjunction of a finishing layer, to complex multi-partitioned constructions, separated with narrow empty spaces and thick nest plugs, with or without a finishing layer. In 14% of the cases *C. japonicum* applied an additional layer of white material - likely uric acid from reptile faeces (*Gekko* spp) - on the last cell partition on both uni- and multi-cellular nests; in another 14% it would apply patches or even layers of a grey/black material likely to be faecal matter and in 14% it applied a layer of transparent resinous material (from an unknown plant source) to the same (Barthélémy 2011).
Cell 1 was 22-190mm long (mean = 104.3mm, *n* = 66), cell 2 was 23-84mm long (mean = 44mm, *n* = 38), cell 3 was 26-116mm long (mean = 39.3mm, *n* = 11) and cell 4 was 19-32mm long (mean = 25.5mm, *n* = 2).
Nests could be characterised by the following (Barthélémy 2011):

- the innermost cells did not necessarily start from the bottom of the trap, but could be initiated anywhere along its length,
- there were no intercalary cells,
- the outermost cell anterior partition formed the nest closure, and

- when the first cell was initiated against the nodal septum the wasp generally did not add a plug of cell material at the posterior end of the cell.

Figure 30 illustrates a typical nest at opening.

Prey
The cells were mass-provisioned with 4-24 small spiders (mean = 11.1, *n* = 52). The vast majority (90%) of them were in the Araneidae family, 7.8% in Tetragnathidae (all represented by four species of *Leucauge*), 2% in Theridiidae and 0.2% in Uloboridae. In fact the majority of all prey were represented by two genera in Araneidae, 49% in *Neoscona* spp. and 33% in *Cyclosa* spp. Males and females were provided although females represented 79% and males 21% of all prey taken. A generational variation was noted in the major species of prey taken. The first active females of the year took a majority of *Neoscona* spp., while their daughters took a majority of *Cyclosa* spp. with *Neoscona* spp. completely absent from the prey records (Barthélémy 2011). **Figure 31** shows the typical prey content of a nest.
On five nests for which prey and sex of brood was determined it was noted that the mother provided fewer prey for males than for females.

Life history
In general it appears that the egg is laid on any of the prey with no particular preference, indicating that oviposition is performed at anytime during prey provisioning. The egg was attached dorso-laterally close to the cephalothoracic-abdominal junction of the prey, the anal end approximately median to the host body (**Figure 32**).
The egg was creamy in colour, slightly arched, with hemispherical ends and a more or less constant diameter of 0.8-0.94mm (mean = 0.86mm; *n* = 29), it was 2.9-3.6mm long (mean = 3.2mm; *n* = 27). It hatched in approximately four days after oviposition (mean = 3.8 days; *n* = 12). The larva fed continuously for about 7 days (mean = 6.8 days; *n* = 10) after which it started to spin a single layered cocoon. They were oblong, with a basal hard and dark capsule and were 17.5 - 25.2mm long (mean = 21.2mm; *n* = 24) with a maximum diameter of 4.5 – 6.7mm (mean = 5.6mm; *n* = 24) the wall thickness was 0.08mm thick (Barthélémy 2011).
Pupation time was measured until emergence from the nest and lasted 39-42 days (mean = 40.8 days; *n* = 9). However, from casual observations it seems that after breaching the cocoon the wasp remained inside the trap/nest for a day at maximum and then emerged. As a rule males emerged before the females, and females cells were always constructed before (posteriorly) to those of males (Barthélémy 2011). **Figures 33 & 34** show a mature larva and a cocoon respectively.
It was observed that *C. japonicum* had two generations per year, the first generation emerging from overwintering brood in May and the second emerging in June. The larvae entered a long diapause in July, overwintering as pre-pupal larvae until end of April of the following year when pupation started.
The sex ratio was noted to be 38 females for 24 males, close to 2:1 female to male.

Natural enemies, associates and brood death
Parasitism was relatively high and 27.2% of all cells were parasitised by either a phorid fly (16.7% of all nests) or *Melittobia* sp.(Eulophidae) (10.6% of all nests).
Small Psocoptera were found in 10 nests. They were present from the beginning until much after brood emergence. They seemed to feed on debris in the nest rather than on the wasp brood. Small mites were recorded in two instances on the brood and later on the adult wasp when it was collected at emergence.
The brood died for reasons not associated with parasitism in 21 cells or 31.8%. When combined with mortality due to parasitism, brood death represented 59% of all cells.

Identification
Chalybion japonicum was identified by Wojciech J. Pulawski, Curator, California Academy of Science, San Francisco, USA. The phorid cleptoparasites and the eulophid parasites were identified by the author.

Family Vespidae, Subfamily Eumeninae.

Allorhynchium sp.

I reared this species (**Figure 35**) from 45 nests totalling 76 cells. The traps had boring of 5-11mm in diameter (mean = 8mm, *n* = 45) and were 155-225mm long (mean = 177.5mm, *n* = 45). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in December 2008, November and December 2009, May to September 2010, November 2010, March 2011 and from June to September 2011.

Nest architecture. *Allorhynchium* sp. constructed 1-4 cells per nest (mean 1.7, *n* = 45). Nests were characterised by the following:

- they were all terminated by a vestibular chamber, defined by the anterior partition of the last cell and the opening of the bamboo segment, this chamber being used as a sheltering space for the initiating mother,
- there were no intercalary cells,
- cells could be initiated anywhere along the tube length, although in most cases the trap end (nodal septum) defined the posterior end of the first cell, and
- the wasp would deposit cell partition material on the posterior end of the first cell if it had been initiated against the nodal septum.

The cell partitions were generally very weak and constructed from plant resin/gum of unknown origin. The nest entrance

was always terminated by a collar of resinous material, a structure homologous to the mud turret of other eumenines. It could be modified to form a more or less tubular entrance, depending on the inclination of the trap such that the entrance threshold plane was always vertical. When the diameter of the nest trap was larger than usual the entrance collar could be extended to form a neck, a shallow tubular extension to the collar (**Figure 36**).

On a number of traps it was noted that the wasp randomly applied resinous material to the outer surface of the bamboo segment for no apparent reason. This resinous material was an effective ant repellent as observed *in-situ.*

The wasp was clearly a tube renter as was noted by Iwata (1976) for *Allorhynchium* spp. and bamboo canes were the only nesting sites ever recorded.

The majority of the traps had few cells, 46.7% of all nests had one cell, 42.2% had two cells, 6.7% had three cells and 4.4% had four cells. Cell 1 was 17-138mm long (mean = 68.8mm, *n* = 41), cell 2 was 13-142mm long (mean = 65.7mm, *n* = 21), cell 3 was 14-48mm long (mean = 32.8mm, *n* = 5) and cell 4 was 20-22mm long (mean = 20.9mm, *n* =2).

Prey

The brood was provided with caterpillars in the family Tortricidae. In one nest the provision was identified as *Homona coffearia* (Neitner,1861). Dissection of nests showed that in the early stages of brood development the mother progressively provided prey to the larva as it developed, leaving the brood cell open until the larva was close to maturity. The wasp then mass-provisioned the cell with 3-5 caterpillars and sealed it with a thin opercula leaving an open vestibular chamber which was used by the mother as a shelter for prolongued periods of time, sometimes over the winter months untill March of the following year. In fact this behaviour coud be better termed as truncated progessive provisioning (**Figures 37 & 38**).

Life history

The egg was laid before prey were provided and it was suspended by a silk thread at the posterior end of the cell. It was creamy in colour, slightly arched and measured 4.028-4.295mm in length (mean = 4.154mm, *n* = 3) and 1-1.180mm in diameter (mean = 1.094mm, *n* = 3) (all measurements taken on enlarged scaled photographs).

On five nests for which I ascertained its initiating time I noted that the brood development period (from oviposition to emergence) was 26-43 days (mean 34.4, *n* = 5). The last generation brood would overwinter as a pre-pupal larva and spend typically 120-137 days in diapause (average 131.1, *n* = 13). **Figure 39** shows pupating larvae. The fecundity of *Allorhynchium* sp. was much less than that of other solitary eumenine species that do not perform progressive provisioning, in accordance with observations by others (Evans and West-Eberhard 1970; Iwata 1976; Cowan 1991), a single female would complete 4-8 cells in her lifetime.

As a rule the first cells (cells 1 & 2) contained female specimens, while the terminal cells contained males.

This wasp is observed all year round and is active on warm days during the over-wintering period. However, Malaise trapping records and casual hand netting of the species show that it is most active between May and November.

Over-wintering females are commonly found in nests, along with over-wintering brood. Trap PSO-118.A2 was collected on 06 March 2011. A female had been sheltering in it since mid-October when she first initiated the nest, which contained at that time two pre-pupa larvae. The trap was kept and the female survived until the 06 April 2011 with the brood emerging as females on 04 May 2011. Dissection of the ovaries of the mother showed that while the spermatheca contained sperm, the ovaries were degenerated and showed no sign of development.

Considering a brood developmental time of around 35 days it can be inferred that this wasp has at least four generations annually in Hong Kong the last one over-wintering as a per-pupal larva. Recent observations have shown that this wasp was still initiating new nests in early November 2011.

Sex ratio was obtained for 57 active cells, 36 yielded females (63.2%) and 21 males (36.8%) or a ratio close to 2:1 females to males.

The re-use of a nesting site by the same species (natal nest?) over the breeding season had been noticed at tube opening. This was established by the fact that several nests had breached pupating chamber diaphragms attesting to the emergence of previous generations. The re-use of vacated cells/nests seems to be a relatively common feature of many subsocial eumenines and has been documented for several species such as *Xenorhynchium nitidulum* (Fabricius 1798) or *Orancistrocerus drewseni* (Saussure, 1857) (Itino 1986, West-Eberhard 1987).

On four nests out of 42 studied, *Allorhynchium* sp. superseded other Aculeata, in three instances a species of Megachilidae and in one instance a sphecid, *Chalybion japonicum* (Gribodo, 1883). On one trap *Allorhynchium* sp. was superseded by *Isodontia diodon* (Kohl, 1890).

Allorhynchium sp. often shared nesting sites with other arthropods, notably ants in the genus *Crematogaster* and *Camponotus*, *Isodontia diodon* (Sphecidae) and spiders.

Natural enemies, associates and brood death

Incidences of parasitism were very low and only seven cells (9.2%) out of 76 analysed were parasitised by what appeared to be Hymenoptera. On two nests the parasitised cells contained several medium sized grubs and the empty integument of the host wasp larva. These grubs were identified as larvae of Leucospidae at emergence of the parasite. Additionally *Melittobia* sp. (Eulophidae) were recorded in two traps.

Mites were recorded on a couple of nests and the presence of small Psocoptera was noted in one instance.

In ten cells out of 76 the brood died during development for reasons not associated with parasitism or fungal infection. This represents a mortality of 13.2% and when combined

with the mortality due to parasitism the total brood death was 21.1%.
This low level of parasitism is consistent with what is generally observed for wasps that practice progressive provisioning and it is generally assumed that the continuous presence of the mother during the developmental stages of the brood affords a greater protection against natural enemies (Evans and West-Eberhard 1970; Itino 1986; Cowan 1991).

Identification
The wasp was identified by Jun-Ichi Kojima, Natural History Laboratory, Faculty of Science, Ibaraki University, Japan, while the leucospid and the eulophid parasites was identified by the author.

Anterhynchium sp.

I reared this eumenine (**Figure 40**) from 20 nests totalling 53 cells. The traps had boring of 7-13mm in diameter (mean = 8.6mm, *n* = 20) and were 160-250mm long (mean = 168.3mm, *n* = 20). They were all placed in two localities in Hong Kong, my garden (Pak Sha O, Sai Kung Country Park) and Nung Tung Chai (New Territories, UTM: 50Q KK 042 840, 140m asl). They were collected in May 2009 and May to July 2010. *Anterhynchium* Saussure is a widely distributed genus of old world solitary wasps related to *Pseudepipona* Saussure and *Euodynerus* Dalla Torre (Vecht 1963).

Nest architecture
Anterhynchium sp. constructed nests with 1-4 cells (mean = 2.6, *n* = 20). The cells had mud partitions composed of a fine clayish material with inclusion of sand grains.
60% of all nests had one vestibular cell 4-47mm long (mean = 17.7mm, *n* = 12) while 15% had two which were 12-18mm long (mean = 15.2, *n* = 6). 55% of nests had one intercalary cell 4-17mm long (mean = 9.1, *n* =11) whether composed of two or more cells and one nest of four cells had three intercalary cells. 15% of the nests had a preliminary plug composed of the same material as the cell partitions and 35% had a bottom empty cell.
A majority of the nests had two cells (45%), while only 5% had one cell, 30% had three cells and 20% had four cells. Cell 1 measured 22-87mm long (mean = 48.7mm, *n* = 20), cell 2 was 14-58mm long (mean = 35.8mm, *n* = 20), cell 3 was 14-37mm long (mean = 23mm, *n* = 10) and cell 4 was 16-20mm long (mean = 18mm, *n* = 4).

Prey
Each cell was mass-provisioned with 4-11 caterpillars (mean = 6.5, *n* = 13) of the Crambidae family, in one nest these were identified as *Herpetogramma* sp. (Spilomelinae) or *Omiodes* sp. (Spilomelinae). All prey were lightly paralysed able to wriggle and defecate. **Figure 41** show the typical content of a nest at opening.

Life history
The egg was suspended by a thin silk thread at the posterior end of the cell approximately 5mm for the partition, it was creamy in colour and slightly arched, measuring 3.24-3.97mm long (mean = 3.463mm, *n* = 9) and 0.92-1.09 in diameter (mean = 1.012mm, *n* = 9) (all measurements taken on enlarged scaled photographs). The egg was laid before the cell was provisioned with prey. At hatching the first instar larva remained attached to the egg case and fed suspended from it for one day at maximum, when it detached itself to feed freely.
It took 2-4 days for the brood to hatch (mean = 3 days, *n* = 4), three days for the larvae to complete feeding and 22-26 days (mean = 24.5 days, *n* = 6) for the brood to pupate and emerge, or an average of 30.4 days from oviposition to emergence of adults (*n* = 5). The post feeding larva did not spin a complete cocoon but wove silk on the anterior cell partition. The pre-pupal larvae and the pupae always had their head towards the nodal septum, which is quite characteristic of this wasp. **Figure 42** shows an egg, a post-feeding larva and a pupa respectively. As a rule the first cells were occupied by female brood save in one case were the two cells composing the nest contained only males.
The sex ratio was obtained on 24 brood, with 18 females for 6 males or a 3:1 female to male ratio.
Although most nests were reared early in the season, it can be inferred from the average development time that this species has two to three generations per year, with the last generation probably overwintering as a pre-pupal larva.
It was noted that the mother would at times shelter during rainy days and spend the night in her nest.
Activities of the adult wasp on the nesting site were recorded over a period of two hours 47 minutes. It was noted that the wasp spent 40.5% of her time foraging for construction material, 35.9% of her time applying this material, 16.2% of her time was used for prey foraging and 1.3% of the time placing these preys items in the cells. 2.5% of her time was spent inspecting the nesting site and 3.6% was spent on foraging trips that were unsuccessful.

Natural enemies, associates and brood death
Four cells out of 53 were parasitised (7.5%) by phorid flies (cleptoparasite) and seven (13.2%) had been attacked by *Monomorium floricola* (Formicidae). In addition to this, nine nests (45%) contained mites at various stages of development. These acari were transported by the adult attached at the joint of the first abdominal sternite. Small Psocoptera were also present in three nests (15%) but were not lethal.
Brood died during development in 15 cells (28.3%) for reasons not associated with parasitism with fungal infections responsible for five deaths. When combined with parasistism the total brood death was 49% of all cells.
Identification
The wasp was identified by Jun-Ichi Kojima, Natural History Laboratory, Faculty of Science, Ibaraki University, Japan.

The prey were identified by Roger Kendrick, Kong Kong while the phorid cleptoparasite and the ant were identified by the author.

Apodynerus sp.

I reared this eumenine (**Figure 43**) from five nests totalling 13 cells. The traps had borings of 4-5.5mm in diameter (mean = 4. 8mm, *n* = 5) and were 165-174mm long (mean = 169.4mm, *n* = 5). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in March and June 2011.

Nest architecture
Apodynerus sp. constructed nest with 1-4 cells (mean = 2.8, *n* = 5). The cells had mud partitions composed of a fine clayish material with inclusion of sand grains.
Two out of five nest (40%) had a vestibular cell which was 38-104mm long (mean = 71mm, *n* = 2), one nest (20%) had an intercalary cell 10mm long and one nest (20%) had a preliminary plug constructed out of the same material as the cell partitions. **Figure 44** shows the content of a nest at opening.
20 % of all nests had one cell, 20% two cells, 40% three cells and 20% four cells. Cell 1 measured 12-31mm long (mean = 17.4mm, *n* = 5), cell 2 was 10-23mm long (mean = 15.5, *n* = 4), cell 3 was 12-14mm long (mean = 13mm, *n* = 3) and cell 4 was 16mm long (*n* = 1).

Life history
On one nest *Apodynerus* sp. superseded *Trypoxylon formosicola* as shown on **Figure 45**. *T. formosicola* adults later emerged without damaging the eumenid brood. Also in two nests the wasp entombed a queen *Crematogaster* sp. (Formicidae) as shown on **Figure 46**. **Figure 47** shows mature larvae and advanced pupae. Nests were either all males or all females and a sex ratio of five males to four females was obtained or approximately 1:1 male to female.

Prey
I was unable to determine the species or even the family of the prey as only caterpillar remnants were found. However, it is likely that the wasp practiced mass-provisioning as this is known for many eumenids.

Natural enemies, associates and brood death
No parasites were reared from this species, most likely due to the small sampling range, but as with other eumenines it is very probable that both phorid flies and chrysidid wasps would parasitise this species.
Mites were recorded on all but one nest. They were found on both the debris inside the cells and on the brood. They were located on the basal part of the propodeum on an advanced pupa.

Identification. The wasp was identified by Jun-Ichi Kojima, Natural History Laboratory, Faculty of Science, Ibaraki University, Japan.

Pararrhynchium sp.

I reared this eumenine (**Figure 48**) from 11 nests totalling 25 cells. The traps had boring of 7.4-14mm in diameter (mean = 10.3mm, *n* = 10) and were 165-250mm long (mean = 188mm, *n* = 10). They were all placed in two localities in Hong Kong, my garden (Pak Sha O, Sai Kung Country Park) and Ha Tin Liu Ha (New Territories). They were collected in December 2008, May, July & August 2009, May and September 2010.

Nest architecture
Pararrhynchium sp. constructed nests with 1-5 cells (mean 2.1, *n* = 9). The cells had mud partitions composed of a fine clayish material with inclusion of sand grains. Eight out of 11 nests (72.7%) had a vestibular cell 7-108mm long (mean = 50.6mm, *n* = 8), three nests (27.3%) had one intercalary cell 11-55mm long (mean = 35.3, *n* = 3), two nests (18.2%) had two intercalary cells 6-15mm long (mean = 9.7mm, *n* = 4) and one nest (9.1%) had three intercalary cells 12-26mm long (mean = 19.3mm, *n* = 3). Three nests (27.3%) had an empty bottom cell 5-20mm long (mean = 12mm, *n* = 3) and a preliminary plug. **Figure 49** shows a trap at opening.
Cell 1 measured 30-60mm long (mean 41mm, *n* = 8), cell 2 was 20-44mm long (mean = 31mm, *n* = 4), cell 3 was 16-26mm long (mean = 21mm, *n* = 2) and cell 4 was 25mm (*n* = 1).
This species, while commonly found in nest-traps also constructed nests in the open, often in sheltered situations under roof overhangs or similar substrates. However Seiki Yamane noted that all four Japanese species were tube renters (Yamane, 1990). The material is identical but the nest form is globular with a long entrance tunnel directed downwards. These globules in fact contained several cells, the wasp building generally several structures agglutinated together (**Figure 50**); the entrance tunnel was terminated at the first cell threshold with a mud closure.

Prey
Each cell was mass-provisioned with 5-10 caterpillars (mean = 8.3, *n* = 7) in the Crambidae family, in two nests these were identified as *Herpetogramma* sp. (Spilomelinae) or *Omiodes* sp. (Spilomelinae). All prey were lightly paralysed able to wriggle and defecate. **Figure 51** shows the typical content of a nest at opening. Seiki Yamane noted that *Pararrhynchium ornatum ornatum* (Smith) provisioned progressively the brood with prey and only sealed the cells when development was near completion (Yamane 1990), behaviour that has not been observed with the present species.

Life history
The egg was suspended by a thin silk thread at the posterior end of the cell. It was creamy in colour and slightly arched, measuring 3.13-3.213mm long (mean = 3.17mm, *n* = 2)

and 0,967-1.016 in diameter (mean = 0.991mm, *n* = 2) (all measurements taken on enlarged scaled photographs). The egg was laid before the cell was provisioned with prey. At hatching the first instar larva remained attached to the egg case and fed suspended from it for one day at maximum, when it detached itself to feed freely.
The egg hatched in 2-3 days (mean 2.5 days, *n* = 2), it took four days for the larvae to complete feeding, the pre-pupal stage lasted 7-8 days (mean = 7.5 days, *n* = 2) and the pupal stage took 14-18days (mean = 16 days, *n* = 2), or 28-32 days (mean = 30 days, *n* = 2) from oviposition to emergence of adult. **Figure 52** shows an egg a mature larva and a pupa respectively. The post-feeding larva does not spin a complete cocoon but fabricated an operculum against the anterior partition if the cell was short or divided the cell if the latter was long.
Other species of *Pararrhynchium* are known to shelter in their nests for prolonged periods of time and *Pararrhynchium ornatum ornatum* is known to be primitively social practising progressive provisioning (Yamane 1990), however this was not observed for this particular species. On 12 brood a sex ratio of 1:1 female to males was obtained.
Considering the long flight period of this wasp (May to September at least) and the relatively short development period, it can be inferred that this species is at least bi-voltine in Hong Kong.

Natural enemies, associates and brood death
Four cells out of 25 observed (16%) were parasitised by a chrysidid wasp, identified as *Praestochrysis* sp. and no other parasites were noted. From one observation it is likely that the parasite penetrated the nest soon after the mother had sealed the cell. It laid its egg which hatched before that of the host, destroying it and feeding on the prey provision. It took approximately 26 days for the parasite to develop and emerge. Six nests out of 11 (54.4%) had acari present, feeding at first on the prey and then on the larvae when they were large enough.
The brood died for reasons not associated with parasitism in nine cells out of 25 (36%) and when combined with death due to parasitism the total brood mortality was 52%.

Identification
The wasp was identified by Jun-Ichi Kojima, Natural History Laboratory, Faculty of Science, Ibaraki University, Japan. The chrysidid parasite was identified by the author and the prey were identified by Roger Kendrick, Hong Kong.

Pareumenes sp.

I reared this species (**Figure 53**) from six nests totalling six cells. The traps had borings of 6.7-10.5mm in diameter (mean = 8.7mm, *n* = 6) and were 127-250mm long (mean = 181mm, *n* = 6). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in September 2008 and May 2009.

Nest architecture
All traps collected contained nests with only one cell which was 29-141mm long (mean = 74.2, *n* = 6). The cell had a mud partition fashioned out of soil (with clay content) and inclusion of sand grains. All six nests had a vestibular cell 55-191mm long (mean = 115.8mm, *n* = 6) and in two cases this vestibular cell was subdivided by an embryonic partition forming a much smaller cell posteriorly. Two nests had an empty bottom cell 22-23mm long (mean = 22.5, *n* =2). **Figure 54** shows a trap at opening.

Prey
Each cell was mass-provisioned with 2-3 caterpillars (mean 2.5, *n* = 2) of an unknown species (**Figure 55**). All prey were lightly paralysed able to move a little and to defecate.

Life history
The egg was suspended by a thin silk thread at the posterior end of the cell. It was creamy in colour and wider apically. I was able to take measurements for one egg, which was 4.03mm long and 1.3mm in diameter at its largest (measurements taken on enlarged scaled photographs). The egg was laid before the cell was provisioned with prey. The development time of the brood until emergence was measured on one cell and took approximately 30 days. The post-feeding larva spun white silk on the cell walls and posterior cell partition, a silk operculum was constructed anteriorly forming a cocoon strongly adherent to the trap. **Figure 56** shows an egg and a mature larva.
On four brood for which I was able to determine the sex I obtained three females and one male, or a strongly female biased ratio of 3:1.
Considering the flight period from May to September at least and the development time of the brood it can be inferred that this species is at least bi-voltine in Hong Kong.
In one instance *Pareumenes* sp. superseded a species of *Trypoxylon*, likely *T. petiolatum* Smith, 1858.
I reared one individual of this species with sexual abnormalities (gynandromorphism) apparent on the clypeus and the antennae, which is a very rare occurrence in Eumeninae (Turrisi 2008).

Natural enemies, associates and brood death
Surprisingly none of the studied nests were parasitised nor did they contain associates such as mites. Additionally there was no endogenous brood mortality.

Identification
The wasp was identified by Jun-Ichi Kojima, Natural History Laboratory, Faculty of Science, Ibaraki University, Japan.

Xenorhynchium sp.

I reared this species (**Figure 57**) from 53 nests totalling 139 cells. The traps had borings of 5-14mm in diameter (mean = 9.2mm, *n* = 53) and were 139-253mm long (mean = 179mm, *n* = 53). They were all placed in three localities

in Hong Kong, my garden (Pak Sha O, Sai Kung Country Park), Ng Tung Chai (New Territories) and Sha Lo Tong (New Territories, UTM: 50Q KK 100 886' 180m asl). They were collected in June, July and November 2009, May, July, September, October and November 2010 and March, May, June, July and September 2011.

Nest architecture

This eumenid constructed nests with 1-7 cells (mean = 2.7, *n* = 52). 27% of nests had one cell, 21.1% had two cells, 25% had three cells, 13.5% had four cells, 7.7% had five cells, 3.8% had six cells and 1.9% had seven cells. Cell 1 was longer than cell 2 which was longer than cell 3 and so on. Cell 1 was 15-103mm long (mean = 36mm, *n* = 47), cell 2 was 12-63mm long (mean = 28.9mm, *n* = 35), Cell 3 was 13-60mm long (mean = 26.3mm, *n* =26), cell 4 was 8-44mm long (mean = 23.5mm, *n* =13), cell 5 was 14-28mm long (mean = 19.8mm, *n* = 5), cell 6 was 19-24mm long (mean = 21.3mm, *n* = 3) and cell 7 was 20mm long (n =1). 88.2% of the nests had one or several vestibular cells , of these 41.2% had one while 58.8% had multiple vestibular cells. They measured 5-202mm (mean = 38.6mm, *n* = 68). 59.6% had single or multiple intercalary cells which measured 5-76mm long (mean = 15.7mm, *n* =39). 26.8% had a bottom empty cell which measured 4-54mm long (mean = 21mm, *n* = 10). The cell partitions and nest plugs were constructed from a clayish material with inclusions of sand grains. **Figure 58** shows a trap at opening.

Prey

Each cell was mass-provisioned with 2-17 caterpillars (mean = 7.5, *n* = 35). In six nests these prey were identified as *Herpetogramma* sp. (Crambidae; Spilomelinae) or *Omiodes* sp. (Crambidae; Spilomelinae). The prey were lightly paralysed and able to defecate. **Figure 58** shows the prey content of one nest. West-Eberhard (1987), reports that one species of this genus, *X. nitidulum* practices truncated progressive provisioning, but such behaviour was not observed for the present species.

Life history

The egg was suspended from the cell wall by a thin silk thread and was laid on or very close to the posterior cell partition, likely before prey provision. It was creamy in colour and slightly arched, measuring 2.981-3.2mm long (mean = 3.108mm, *n* = 5) and 0.962-1mm in diameter (mean = 0.989mm, *n* = 5) (all measurements taken on enlarged scaled photographs). It took 20-31 days (mean = 24.6 days, *n* = 7) for the brood to complete development and emerge as an adult. The last generation brood overwintered (diapause) in the nest to emerge the following spring between April and May. The pre-pupal larva smeared the cell walls and partitions with a silk lining and all larvae had their heads orientated towards the nodal septum. **Figure 59** shows an egg, a pre-pupal larva and a pupa.

There was an overwhelming male bias for this species and 70.1% of emerged adults were males while 29.9% were females, or a ratio superior to 2:1 males to females. Of the 33 nests for which I was able to determine the sex of the brood cells, 19 were unisexual nests (all males), however in bisexual nests, female cells were situated posteriorly, with one exception where the last cell (on a nest of seven) had a female brood. Thirteen male-only nests were located in traps that were part of the same bundle with more than likely the same initiating mother, and this could have been caused by a non-inseminated female.

This eumenine is active from early May to mid-November, consequently it can be inferred that this species is at least bi-voltine in Hong Kong.

In two nests *Xenorhynchium* sp. superseded an unidentified megachile, the eumenid also superseded *Trypoxylon* sp. (Crabronidae) and *Camponotus* sp. (Formicidae) in one case each. In one instance *Isodontia diodon* (Sphecidae) superseded *Xenorhynchium* sp.

Natural enemies, associates and brood death

Twenty-two cells (15.8%) were parasitised. Of these 41.2% were attacked by *Hadrocryptus perforator* (Ichneumonidae, Cryptinae), 17.6% were parasitised by an unknown chrysidid, 17.6% by a phorid (Diptera), 17.6% by *Amobia* sp. (Diptera, Sarcophagidae) and 5.9% by an unidentified coleopteran, likely a rhipiphorid beetle. One cell of one nest was attacked by *Monomorium floricola* (Formicidae). Acari were found consistently in most nests (47.2%), the adults were carried at the intersection of the pygidium with the next tergum by the adult wasp. The mites fed at first on the prey items and then on the brood when development was sufficient. Both male and female mites were found and eggs were laid essentially on the ventral side of the pre-pupal larvae.

Small Psocoptera were found in only one nest and they seemed to feed on debris inside the cell rather than on the brood.

18% of the brood died during development for reasons not associated with parasitism and when combined with death due to parasitism the total brood mortality was 33.8%.

Identification

The wasp was identified by Jun-Ichi Kojima, Natural History Laboratory, Faculty of Science, Ibaraki University, Japan. The cryptine wasp was identified by Gavin Broad, Natural History Museum, London. The Sarcophagidae cleptoparasite was identified by Leikele Sijstermans, University of Amsterdam, Netherlands, the phorid cleptoparasite fly, the parasitic chrysidid wasp, the ants and the coleopteran parasite were identified by the author and the prey were identified by Roger Kendrick, Hong Kong.

Zethus sp.

I reared this species (**Figure 60**) from 15 nests totalling 33 cells. The traps had borings of 5.5-13mm in diameter (mean = 8.2mm, *n* = 15) and were 160-225mm long (mean = 175mm, *n* = 15). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in November

2009, July and October 2010 and July, August and September 2011.

Nest architecture

Zethus sp. constructed nests with 1-5 cells (mean = 2.2, *n* = 15). 46.7% of all nests had one cell, 20% had two cells, 13.3% had three cells, 13.3% had four cells and 6.7% had five cells. Cell 1 was 16-35mm long (mean = 25.3mm, *n* = 11), cell 2 was 18-136mm long (mean = 49.7mm, *n* = 8), cell 3 was 17-28mm long (mean = 21.5mm, *n* = 4), cell 4 was 15-34mm long (mean = 22mm, *n* = 3) and cell 4 was 22mm long (*n* = 1). 20% of the nests had a vestibular cell which was 15-150mm long (mean = 97.7mm, n = 3) and 26.7% had a bottom empty cell measuring 15-50mm long (mean = 25mm, *n* = 4). Preliminary plugs were present in 46.7% of all nests. **Figure 61** shows a trap at opening.

Zethus spp. are known to use pre-existing burrows either from wood boring beetles or in the ground. This genus may also construct free-standing nests with vegetable matter (Bohart and Stange 1965).

The cell partitions were fabricated with cut leaves from young buds of two undetermined plant species. The leaves were coated with either a labial secretion (the wasp was seen "licking" the leaves) or with a plant resin/gum that somehow cured and rendered them brittle and dark, most likely waterproof. The posterior face of the partition was composed of a loose assemblage of leaves while the anterior face was constructed out of very finely cut leaves smeared with secretions/resin forming a smooth finish. Bohart and Stange (1965) report *Zethus* spp. in the Neotropics using a similar type of material, although mostly on free-standing nests. All nests were terminated by an entrance funnel orientated downwards and constructed out of the same material as the cell partitions (**Figure 62**).

Prey

The cells were generally mass-provisioned with 6-17 small caterpillars (mean 12.7, *n* = 5) mainly in the family Geometridae, save for one prey that was in the family Noctuidae, probably *Spodoptera* sp. They were all lightly paralysed and able to defecate (**Figure 61**). Observations on nesting sites revealed that sometimes the mother would bring back only one prey and remain in the nest for the remainder of the day, which may indicate that this wasp practices truncated progressive provisioning as is noted with other species of *Zethus* in the Western hemisphere (Bohart & Stange 1965). Additionally, at opening of traps I noted that sometimes the cells were not closed off by a partition although prey had been provided to the brood, indicating that the mother would guard and protect her progeny.

Life history

The egg was suspended from the cell wall by a thin silk thread; it was laid very close to the posterior cell partition, likely before prey provision. It was creamy in colour and slightly arched, measuring 3.261-3.362mm long (mean = 3.311mm, *n* = 3) and 0.956-1.115mm in diameter (mean = 1.045mm, *n* = 3) (all measurements taken on enlarged scaled photographs). It took 23-34 days (mean = 30 days, *n* = 3) for the brood to complete development and emerge. The last generation brood overwintered (diapause) in the nest to emerge the following spring between April and May. The pre-pupal larva generally constructed a complete cocoon adherent to the cell walls, often dividing the original cell, the remaining posterior gap filled with prey debris and prey faeces, but in some cases only a partial cocoon was fabricated, more a lining on the cell partitions. **Figure 63** show a mature larva and pupa.

The adult wasp sheltered in the nest at night and during rainy days, this was also observed for Neotropical species (Bohart & Stange 1965). In one nest collected in November 2009 I found a dying mother sheltering in her nest.

On the nine emerging specimens for which I was able to determine the sex, three were females and six males for a male-biased sex ratio of 2:1.

Although the diapausing brood seemed to emerge in April or May, I noted that nesting activity was essentially concentrated from end of June until October, therefore it can be inferred that this wasp is at least bi-voltine in Hong Kong.

From the limited data I possess relative to the spatial position of sexes, I assume that the first cells constructed are female cells while the outer one are males.

Natural enemies, associates and brood death

Five cells out of 30 (16.7%) were parasitised, of which three (60%) were attacked by an unidentified phorid fly and two (40%) by *Hadrocryptus perforator* (Ichneumonidae, Cryptinae). One cell of one nest had adult and nymphs of an unidentified thrip (Thysanoptera) present and one cell of another nest was infested by small unidentified mites, most likely *Tyrophagus putrescntiae* (Shrank, 1781).

The brood died for reasons not associated with parasitism in 13 cells (43.3%) and when combined to parasitism the total brood mortality was 60%.

Identification

The wasp was identified by Jun-Ichi Kojima, Natural History Laboratory, Faculty of Science, Ibaraki University, Japan and the prey were identified by Roger Kendrick, Hong Kong. The cryptine wasp was identified by Gavin Broad, Natural History Museum, London. The phorid and other associates were identified by the author.

Family Pompilidae, Subfamily Pepsinae

Auplopus sp2.

I reared this species from two traps totalling seven cells but I found two other nests with a total of six cells from which all brood had emerged. The traps had borings of 9-13.5mm in diameter (mean = 11.4mm, *n* = 4) and were 170-260mm long (mean = 206.2mm, *n* = 4). They were all placed in two localities, my garden (Pak Sha O, Sai Kung Country Park)

and Ng Tung Chai (New Territories). They were collected in July, November and December 2009.

Nest architecture
This spider wasp constructed 2-6 agglutinated ovoid mud pots (mean 4.3, *n* =3) within the tube. The cells were fabricated with globules of mud laid in successive layers (**Figure 64**).

Prey
I was not able to retrieve any prey, but as with other pompilid this species provisioned one single spider prey per cell.

Life history
I only collected limited data on the life history of this wasp. From a trap collected in November emerged one female in March of the following year, therefore it can be assumed that the last generation overwinters as a pre-pupal larva or as a pupa. The larva spun a uniform silk lining on the cell walls forming a complete cocoon.
I was unable to determine the sex ratio of this wasp.

Natural enemies, associates and brood death
Similarly to the life history, I only obtained fragmentary data concerning enemies. On six active cells, two were parasitised (33.3%) by a small unidentified dipteran. The brood died for reasons not associated with parasitism in one cell (16.7%) and when combined with death due to parasitism the total brood mortality was 50%.
Ironically, on two occasions the traps had been used as a shelter and nest by an unidentified salticid.

Identification.
The wasp was identified by James Pitt, Department of Biology, Utah State University, USA.

Auplopus sp3.

I reared this species (**Figure 65**) from a single trap placed in my garden (Pak Sha O, Sai Kung Country Park) and collected on 13 March 2011. It was 8mm in diameter and 160mm long.
Due to the lack of data I cannot report any particularities on its life history or enemies, save for the fact that the nest had been initiated the previous year and the brood diapauses in pupal stage. At opening the nest contained two cocoons and two females emerged on 4 April 2011.

Prey
I observed this species hunt and capture a small lycosid, possibly *Hippasa* sp. or *Alopecosa* sp. This spider builds funnel-like webs extending from a small hole, generally in branches. The funnel was a complex tangle of silk strands. When the wasp located the prey she landed on the web; unable to fly due to the silk strands, and walked about searching for its prey trying to flush it out of its lair or forcing the spider to drop to the ground, where the predator soon located its prey and stung it several times, apparently on the abdomen. She then proceeded to amputate its legs, straddled it and walked carrying her capture ventrally to her nest, several metres away up in a tree. A hunting technique and prey bearing a striking resemblance (save for the amputation) to that described for *Tachypompilus analis* (Pompilinae) (Barthelemy 2010c).

Identification
The wasp was identified by James Pitt, Department of Biology, Utah State University, USA and the prey by Dickson Wong, Hong Kong.

Dipogon sp.

I reared this species from a single trap placed in my garden (Pak Sha O, Sai Kung Country Park) and collected on 13 March 2011. It was 4.5mm in diameter and 140mm long. Due to the lack of data I cannot report any particularities on its life history or enemies save for the fact that the nest had been initiated the previous year and the brood diapauses in pre-pupal or pupal stage. At opening the nest contained three cocoons and two males emerged on 3 April 2011 (I damaged one cocoon at opening). The wasp constructed cells by dividing the tube with mud partitions, similar to eumenines, but in great contrast to the two other pompilids described above.

Identification
The wasp was identified by James Pitt, Department of Biology, Utah State University, USA.

Family Megachillidae, subfamily Megachilinae

Chalicodoma sp.

I reared this species (**Figure 66**) from 10 traps totalling 33 cells. The traps had boring of 7-13.5mm in diameter (mean 9.7 mm, *n* = 10) and were 162-195mm long (mean 172.9mm, *n* = 10). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in October 2009 and September 2011.

Nest architecture
Chalicodoma sp. constructed 1-7 cells (mean = 3.6, *n* = 8). The bee started by building a mud/clay posterior partition, the convexity facing the nodal septum, and then continued anteriorly by applying a uniform layer of clayish material approximately 1mm thick on the inner face of the cavity. Once the desired cell length was achieved it added a uniform layer of resinous material internally which exuded a potent smell. This layer remained sticky for several weeks and then started to harden. The cell was then provisioned posteriorly with a mixture of pollen and probably nectar (and possibly body secretions) and an egg laid on it. The bee then proceeded to the construction of the next cell. Cell 1 was 10-15mm long (mean = 12.1mm, *n* = 7), cell 2 was 12-15mm long (mean = 12.8mm, *n* = 6), cell 3 was 10-

16mm long (mean = 13.2mm, *n* = 5), cell 4 was 12mm long (*n* = 2) and cell 5 was 11-12mm long (mean = 11.5, *n* =2). **Figure 67** shows a nest content at opening.
The notable feature of these nest was the potent smell of the resin used by the bee. It has been demonstrated that resin collected by four *Chalicodoma* spp. in Papua New Guinea effectively inhibited growth of pollen associated fungus (Messer 1985) and therefore afforded a great protection to the brood. Some resins are also known to be anti-microbial and contain potent antioxidants which could retard agents that spoil the food source of the brood (Cane 1996). I was unable to confirm or infirm any of the properties described above in the present *Chalicodoma* sp. It may also be possible that the resin provided an effective repellent against ants or other enemies (cleptoparasites and parasitoids).

Life history
The egg was approximately centred on the pollen mixture mass, the wide end inserted in the food provision.It was white and slightly arched, measuring approximately 4mm in length (mean = 4.14mm, *n* =2) and approximately 1.2mm in diameter at the widest (mean = 1.28, *n* =2) (all measurements taken on enlarged scaled photographs). In a nest collected late in the season (mid October) the egg hatched in 7-12 days and it took approximately three months for the larvae to reach post-feeding stage and start spinning a complete cocoon. The larvae overwintered in pre-pupal stage. Emergence of adults was spread between March and July and in one case an overwintering brood emerged in September, approximately 11 months after the mother had laid the egg. **Figure 68** shows an egg and a young larva.
I always collected nests of this species late in the season (October) and when considering the brood development time, it may be inferred that this species is uni-voltine in Hong Kong. In fact the life cycle of this bee might coincide with the resin production of the plant source.
This bee carried mud balls with her mandibles and applied it to the trap walls. The resin was carried in a similar fashion, although I suspect bristles underneath the mandibles provided the support for this material. Pollen was carried on the setae lining the abdominal sterna (scopa) and brushed inside the cell with the posterior legs. When the bee returned with a pollen load she systematically entered the nest head first, possibly regurgitating nectar on the posterior end of the cell, then exited, turned around and re-entered the nest metasoma first to brush the pollen off on the nectar base.
I time-recorded activities on the nest for a period of two hours 48mins over two days. These were divided into four categories, namely, material foraging, time inside for applying material, pollen foraging and time inside for depositing pollen (and nectar). The bee spent 20% of her time foraging for material (mean = 109 seconds, *n* = 20), 20% of her time applying this material (mean = 113 seconds, *n* = 18), 50% of her time foraging for pollen (mean = 850 seconds, *n* = 6) and 10% of her time depositing pollen (and nectar) (mean = 81 seconds, *n* =12).

Natural enemies, associates and brood death
No parasites per se were observed, however minute mites of the species *Tyrophagus putrescntiae* (Shrank, 1781) were seen in several cases and became highly invasive feeding not only on the pollen mass but also on the brood and apparently killing it, although these mites are known to be scavengers, but may be very aggressive in search of food (Kimiko Okabe, pers. comm.). It is not clear whether these acari were present at nest initiation or were accidently introduced during my opening of the trap, 15 cells (45.5%) were attacked and destroyed in this fashion.
The brood died for reasons not associated with parasitism in 2 cells (6.1%) and when combined with mite attack the total brood mortality was 51.6%.

Identification.
The bee was identified by the author and the mites by Kimiko Okabe, Forestry & Forest Products Research Institute, Ibaraki, Japan.

Megachile spp.

I reared three different species in this genus (**Figures 69, 70 & 71**) but I was unable to identify the specimens to species level, either by lack of keys to species despite detailed subgeneric keys (Michener 2007) or by inconclusive keys and doubtful scientific rigour (Wu Yanru 2006). All traps were placed in two localities in Hong Kong, my garden (Pak Sha O, Sai Kung Country Park, New Territories) and Sha Lo Tong (New Territories) and were collected in May 2009, February and November 2010 and April 2011.

Nest architecture
Two of the species *Megachile* sp1 (**Figure 69**) & *Megachile* sp2 (**Figure 70**) constructed nests of similar architecture (**Figure 72**). They were composed of a linear succession of interlocking cells formed with cut leaves. The cup was composed of overlapping oblong-shaped cuttings in several layers while the caps were made of 3-7 layers of circular cuttings.All the elements were “glued” tightly together. Leaves from three species of plant seemed to have been commonly used by these bees: *Rosa* sp. (Rosaceae), *Ilex asprella* (Hook & Am.) Champ. Ex Benth. (Aquifoliaceae) and *Phyllodium pulchellum* (L.) Desv. (Papilionaceae). In general such nests contained 1-16 cells (mean = 5.1, *n* = 20) although it has to be noted that some nests were collected before they were completed.
The other species, *Megachile* sp3 (**Figure 71**) fashioned a completely different type of nest (**Figure 73**), which apparently consisted of a resinous construction. I inferred by the random locations of the pupae in the trap and the lack of defined cell partitions that this species may have constructed one cell and laid several eggs within, the larvae developing communally.

Food
All larvae of Megachile fed on a mixture of pollen and nectar collected by the mother. This generally formed a soft mass deposited on the posterior end of the cell (**Figure 74**). However, in a nest of an unidentified species the food mass was semi-liquid (**Figure 75**).
Megachile sp2 was a frequent visitor of flowers of *Vitex negundo* L. var. *cannabifolia* (Seibold &Zucc.) Hand.-Mazz. (Verbenaceae): in fact on a bush of this plant in my garden I could count up to 50 specimens foraging together during sunny days.

Life History
I was not able to collect significant data with regards to the life histories of either species.

Natural enemies, associates and brood death
Megachile sp. fell prey to a number of parasites and cleptoparasites as attested by the various nests that I collected but for which I could not ascertain the species. Flies seemed to be rather common and were represented by *Megaselia* sp. (Phoridae) and *Miltogramma* sp. (Sarcophagidae). The eulophid wasp *Melittobia* sp. was also reported. In one instance in a nest of *Megachile* sp3, one cell had been parasitised by a small hymenopteran and about 15 small grubs were found in a pupal chamber. The same nest later suffered a mass infestation of *Tyrophagus putrescntiae* that destroyed the parasite but also the remaining bee pupa.

Identification
The bees, the phorid flies and the eulophid wasp were identified by the author, while *Miltogramma* sp. was identified by Liekele Sijstermans, University of Amsterdam, Netherlands. The mites were identified by Kimiko Okabe, Forestry & Forest Products Research Institute, Ibaraki, Japan.

Family Colletidae, subfamily Hylaeinae

Hylaeus sp.

I reared this species (**Figure 76**) from four traps totalling 32 cells. The traps had borings of 5-5.5mm in diameter (mean = 5.1mm, *n* =4) and were 165-168mm long (mean = 165.7, *n* = 4). They were all placed in my garden (Pak Sha O, Sai Kung Country Park) and collected in March and June 2011.
Nest architecture
Hylaeus sp. fabricated cells out of a clear single-layered cellophane-like lining which was loosely adherent to the trap walls, although numerous silk stands woven at the ends of the cell provided anchorage (**Figure 70**), in agreement with other species in the family (Krombein 1967, Michener 2007). It has been advanced that this lining serves as both a waterproofing and anti-desiccating agent as well as providing a retaining layer for the usually semi-liquid food provision supplied by the mother (Almeida 2008), a mixture of pollen and nectar. There were 6-9 cells per nest (mean = 8, *n* = 4) which were individually defined as cylindrical sacs with part hemispherical caps at each end (**Figures 77 & 78**) They measured 6-8mm long (mean = 7.2, *n* = 15). On one nest there was one vestibular cell 42.8mm long and on another there were two, measuring respectively 40.3mm and 9.7mm long, unfortunately I did not take note of the presence or absence of a vestibular cell on the other two traps.

Life history
I collected very little data with regards to the life history of this species. The last generation overwintered as a pre-pupal larva and emerged in March-April of the following year. Nests were collected in June with brood at early larval stage and emerging in July, corresponding to a development time of approximately one month. Therefore it can be inferred that this species is multi-voltine in Hong Kong with probably 3-5 generations per year.
From my limited data it seemed that this species was female-biased with a ratio of 4:1 female to male.
The faecal pellets were discharged inside the cell and exuded a strong citric smell. **Figure 79** show larvae and pupa.

Natural enemies, associates and brood death
I did not record any cases of parasitism, however I noted a brood mortality for reasons not associated with parasitism in 15.6% of the cells.

Identification
The bee was identified by the author.

Conclusion

The observations reported here agree well with what is generally known of the biology of representatives of both the families/sub-families and the genera/species described. However, some new elements may be considered, such as the presence of several eggs in one cell for *Isodontia aurifrons*, and the extended parental care of *Allorhynchium* sp.- genera not known for this kind of behaviour. Also the truncated progressive provisioning of *Zethus* sp. and the usage of both mud and resin for *Chalicodoma* sp. which are known to use either of these nesting materials but never in conjunction (Michener 2007).
As most of the trapping occurred in the author's garden it may be of interest to expand the exercise to other localities in Hong Kong or even South China to obtain additional data for species not described here.
It is interesting to note that there was an approximately equal female to male sex ratio for Pompilidae and Megachilidae, a female bias for Crabronidae (approximately 2:1) and for Sphecidae (approximately 3:2) and a small male bias for Vespidae, represented solely by the subfamily Eumeninae (**Figure 80**), although overall the sex ratio was close to 1:1 female to male.

Acknowledgments

I am very grateful to the many people who provided identification of either wasps, parasites or prey, they are all cited in the text. My thanks also go to Graham Reels, Hong Kong who patiently reviewed the original manuscript.

References

Almeida, E.A.B, 2008. Colletidae nesting biology (Hymenoptera: Apoidea). *Apidologie* 39: 16-29.

Barthélémy, C. 2010a. Preliminary observations on the nesting biology of *Trypoxylon petiolatum* Smith, 1858 (Crabronidae, Trypoxylini) in Hong Kong. *Hong Kong Entomological Bulletin*, 2(1): 3-10.

Barthélémy, C. 2010b. Nesting Biology of Isodontia diodon (Kohl, 1890) (Hyemenoptera: Sphecidae) a predator of cockroaches in Hong Kong. *Journal of Hymenoptera Research*, 19(2): 201-216.

Barthélémy, C. 2010c. Preliminary description of the predatory and nesting behaviour of *Tachypompilus analis* (Pompilidae: Pompilinae) in Hong Kong, China. *Hong Kong Entomological Bulletin*, 2(2): 3-9.

Barthélémy, C. 2011. Notes on the biology of the conspicuous mud dauber wasp, *Chalybion japonicum* (Gribodo, 1883) (Sphecidae) a major predator of spiders in Hong Kong. *Hong Kong Entomological Bulletin*, 3(1): 7-14.

Bohart, R.M. and A.S. Menke. 1976. *Sphecid wasps of the world. A Generic Revision*. University of California Press, 695pp.

Bohart, R.M. and L.A. Stange. 1965. A Revision of the Genus *Zethus* in the Western Hemisphere (Hymenoptera: Eumenidae). *University of California Publications in Entomology* 40, 208pp.

Cane, J.H. 1996. Nest Resins Obtained from *Larrea* Pollen Host by and Oligolectic Bee, *Trachusa larrae* (Cockerell) (Hymenoptera: Megachilidae). *Journal of Kansas Entomological Society*, 69(1): 99-102.

Cowan, D.P. 1991. The Solitary and Presocial Vespidae. In *The Social Biology of Wasps*, Ross, K.G. and R.W. Matthews eds. Cornell University Press. 678pp.

Evans, H.E. and M.J.W. Eberhard. 1970. *The wasps*. The University of Michigan Press. Ann Arbor, 265pp.

Itino, T. 1986. Comparaison of Life Tables Between the Solitary Eumenid Wasp *Anterhynchium flavomarginatum* and the Subsocial Eumenid Wasp *Orancistrocerus drewseni* to Evaluate the Adaptive significance of Maternal Care. *Research on Population Ecology* 28: 185-199.

Iwata, K. 1976. *Evolution of Instinct. Comparative Ethology of Hymenoptera*. Amerind Publishing Co. Pvt. Ltd., New Delhi. Translated from the Japanese edition of 1971. 535pp.

Krombein, K.V. 1967. *Trap-Nesting Wasps and Bees: Life Histories, Nests, and Associates*. Smithsonian Press, Washington, D.C, 570pp.

Krombein, K.V. 1991. Biosystematic Studies of Ceylonese Wasps, XIX: Natural history notes in several families (Hymenoptera: Eumenidae, Vespidae, Pompilidae and Crabronidae). *Smithsonian Contributions to Zoology*. 515.

O'Neill, K.M. 2001. *Solitary wasps, behaviour and natural history*. Comstock Publishing Associates. Cornell University Press, 406pp.

Messer, A.C. 1985. Fresh Dipterocarp Resins Gathered by Megachild Bees Inhibit Growth of Pollen-Associated Fungi. *Biotropica* 17(2): 175-176.

Michener, C.D.2007. *The Bees of the World*. 2nd Edition. The Johns Hopkins University Press. 953pp.

Turrisi, G.F. and W. Borsato. 2008. Description of two gynandromorphic Eumenidae (Hymenoptera Vespoidea). *Linzer biol. Beitr*. 40(1): 951-957.

Vecht, J. Van der. 1963. Studies on Indo-Australian and East-Asiatic Eumenidae (Hymenoptera, Vespoidea). *Zoologische Verhandelingen*. 60, 113pp.

West-Eberhard, M.J. 1987. Observations of *Xenorhynchium nitidulum* (Fabricius) (Hymenoptera, Eumeninae), a Primitively Social Wasp. *Psyche* 94(3-4): 317-323.

Wu Yanru. 2006. *Fauna Sinica, Insecta Vol.44, Hymenoptera Megachilidae*. Science Press, Beijing, China. 474pp.

Yamane, S. 1990. A Revision of the Japanese Eumenidae (Hymenoptera Vespoidea). *Insecta Matsumurana* 43, pp87-95.

Figures & Tables

Figure 1: A newly placed trap bundle (photo author).

Figure 2: Nest architecture and terminology from Krombein (1967).

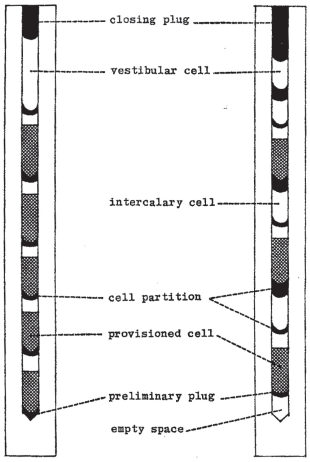


Figure 3: Female *Trypoxylon formosicola* (photo author).

Figure 4: Typical content of nest of *Trypoxylon formosicola* at opening (photo author).

Figure 5: Mature (post feeding) larva of *Trypoxylon formosicola* (photo author).

Figure 6: Cocoon of *Trypoxylon formosicola* (photo author).

Figure 7. *Trypoxylon petiolatum* (photo author).

Figure 8. Typical content of nest of *Trypoxylon petiolatum* at opening (photo author).

Figure 9. Typical prey content of a nest of *T. petiolatum* (photo author).

Figure 10. Oviposition site of *T. petiolatum* (photo author).

Figure 11. Mature larva of *T. petiolatum* (photo author).

Figure 12. Cocoon of *T. petiolatum* (photo author).

Figure 13 *Isodontia diodon* (photo author).

Figure 14. Typical content of nest of *Isodontia diodon* at opening (photo author).

Figure 15. Typical prey content of a nest of *I.diodon* (photo author).

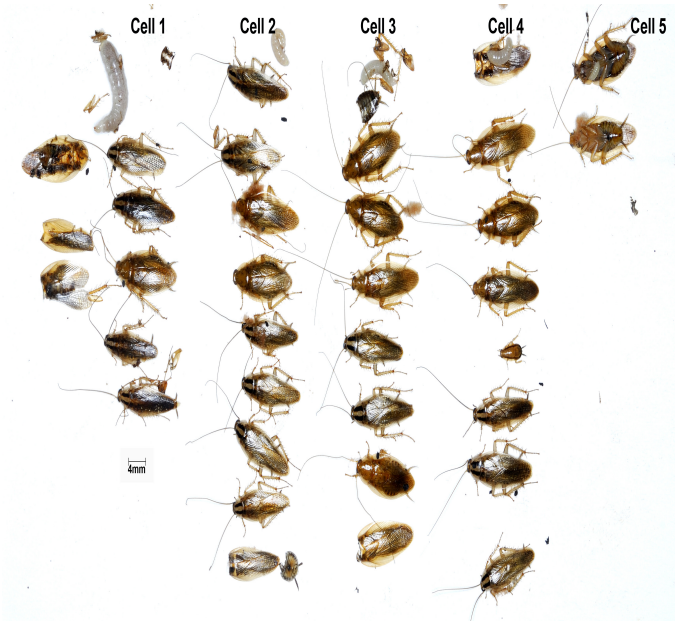


Figure 16. Oviposition site of *I.diodon* (photo author).

Figure 17. Mature larva of *I.diodon* (photo author).

Figure 18. Cocoon of *I.diodon* (photo author).

Figure 19. Female *Isodontia nigella* (photo author).

Figure 20. Typical content of nest of *Isodontia nigella* at opening (photo author).

Figure 21. Typical prey content of a nest of *I.nigella* (photo author).

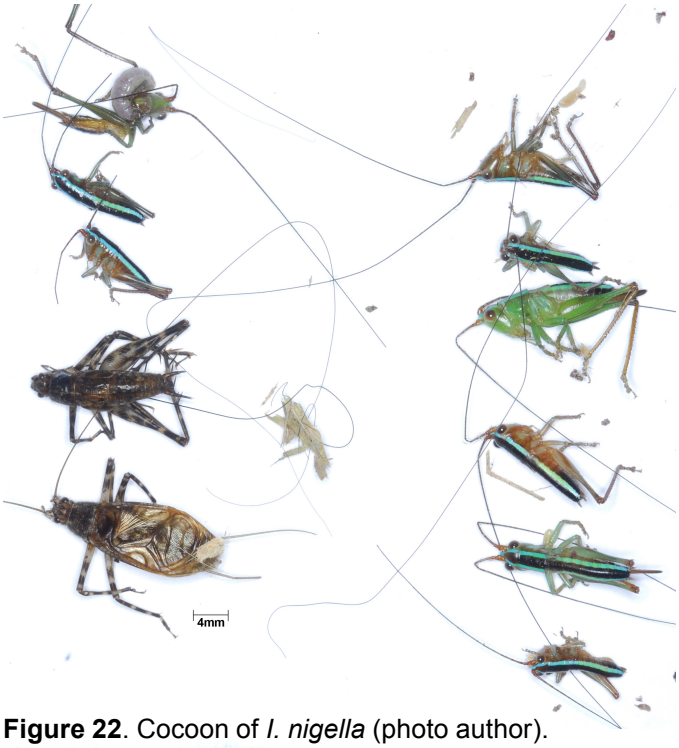


Figure 22. Cocoon of *I. nigella* (photo author).

Figure 24. Typical content of nest of *Isodontia aurifrons* at opening (photo author).

Figure 25. Typical prey content of a nest of *I.aurifrons* (photo author).

Figure 26. Oviposition site of *I.aurifrons* (photo author).

Figure 27. Mature larva of *I.aurifrons* (photo author).

Figure 28. Cocoon of *I.aurifrons* (photo author).

Figure 29. *Chalybion japonicum* (photo author).

Figure 30. Typical content of nest of *Chalybion japonicum* at opening (photo author).

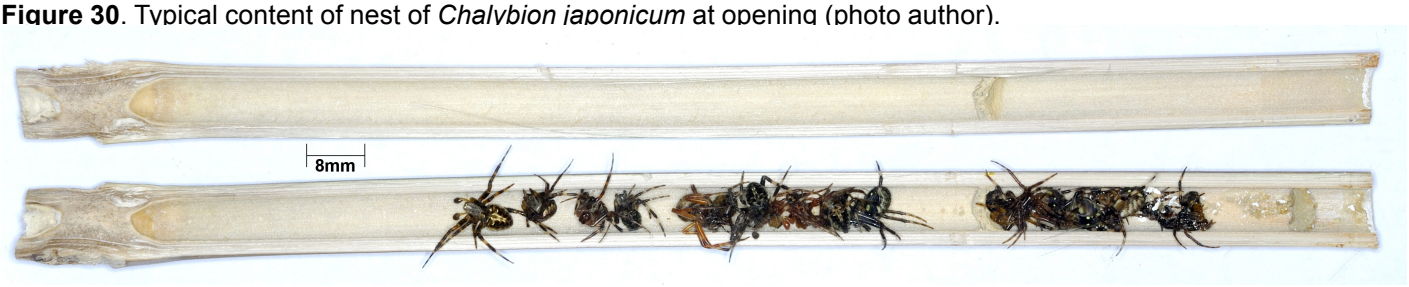


Figure 31. Typical prey content of a nest of *C. japonicum* (photo author).

Figure 32. Oviposition site of *C. japonicum* (photo author).

Figure 33. Mature larva of *C. japonicum* (photo author).

Figure 34. Cocoon of *C. japonicum* (photo author).

Figure 35. *Allorhynchium* sp. (photo author).

Figure 36: *Allorhynchium* sp. **A**: Nest horizontal; threshold reduced to a collar; **B**: Nest inclined; threshold modified forming a hemispherical extension; **C**: Nest vertical; threshold forming an elbow extension; **D**: Nest boring large; threshold forming a collar and neck extension (diagrams by author).

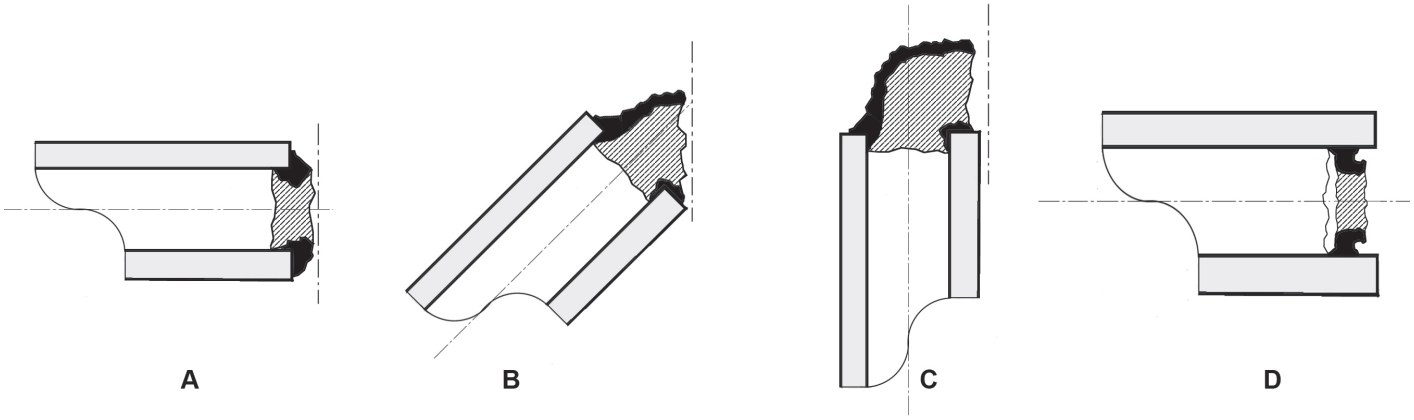


Figure 37: *Allorhynchium* sp. Un-sealed cell with one egg and one prey and enlargement of an egg (photo author).

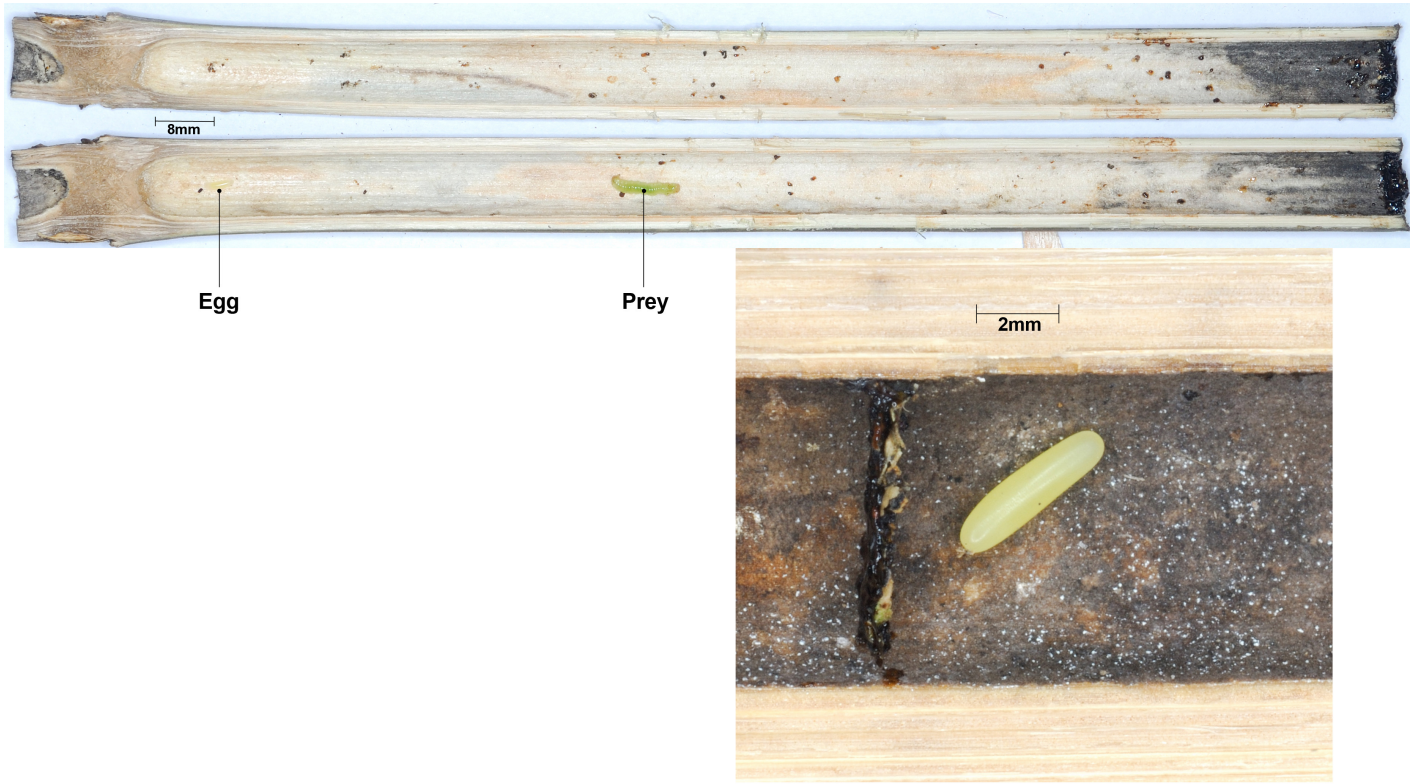


Figure 38: *Allorhynchium* sp. Cell 2 un-sealed with mass provision and a near mature larva (photo author).

Figure 39: *Allorhynchium* sp. Pupation. March 2010 (photo author)

Figure 40. Female *Anterhynchium* sp. (photo author).

Figure 41. Typical content of nest of *Anterhynchium* sp at opening (photo author).

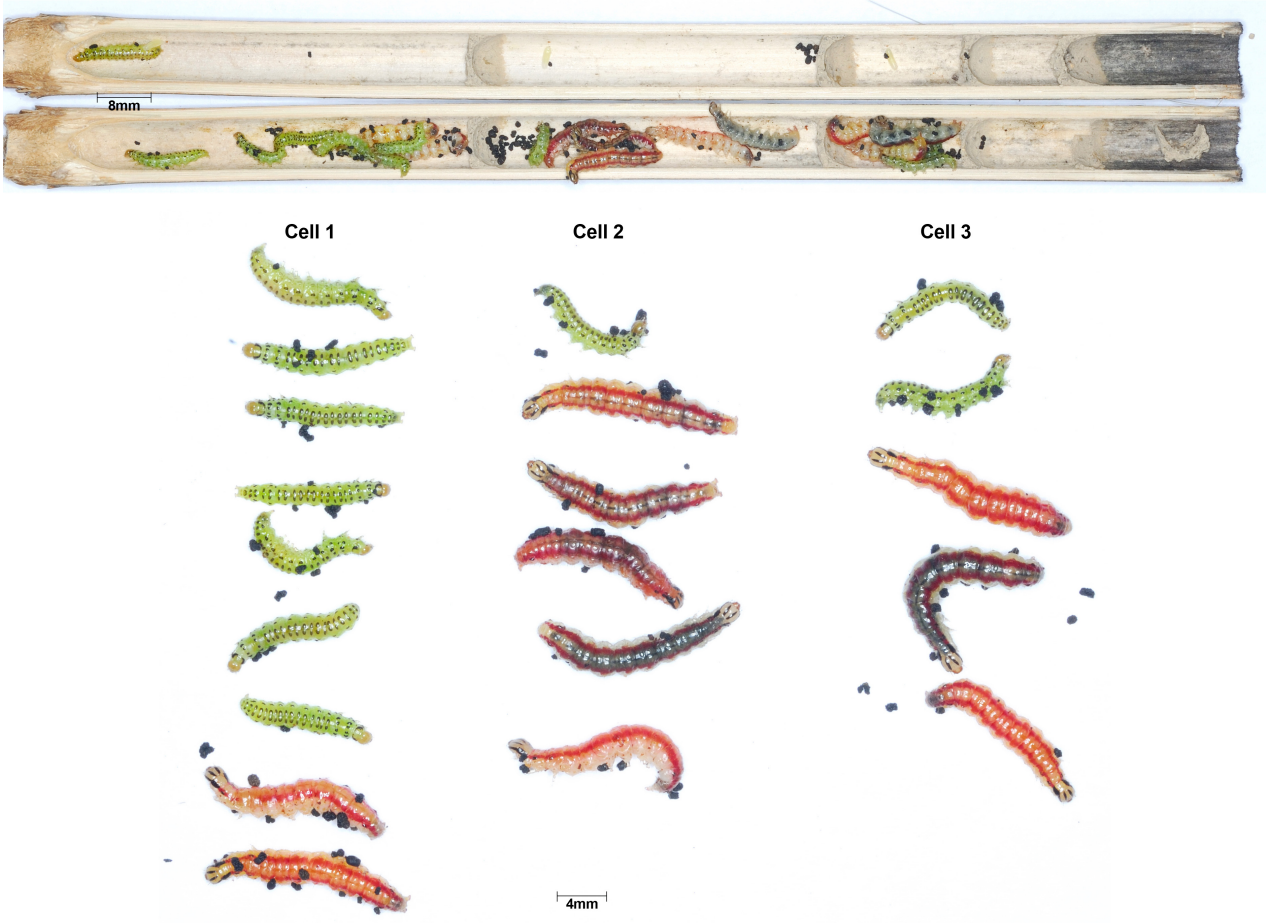


Figure 42. *Anterrhynchium* sp. Top, egg, middle post-feeding larva, bottom, pupa (photo author).

Figure 43. Female *Apodynerus* sp. (photo author).

Figure 44. Content of nest of *Apodynerus* sp. at trap opening (photo author).

Figure 45. Supersedure of *T. formosicola* by *Apodynerus* sp. (photo author).

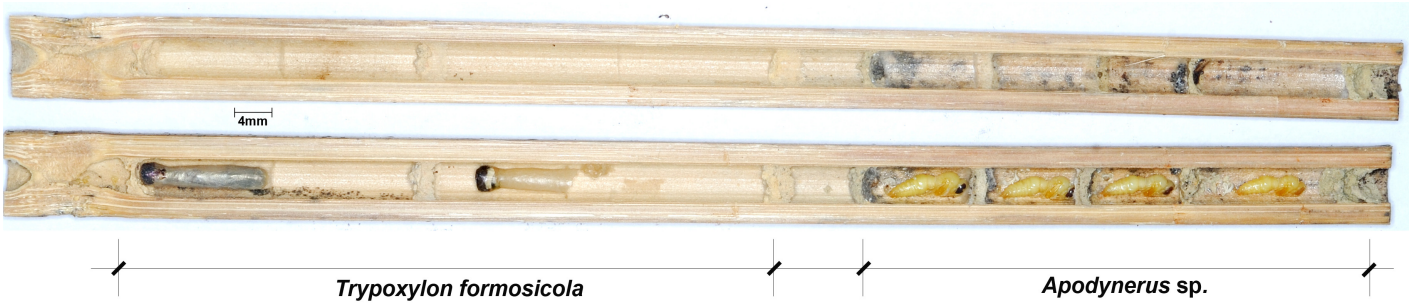


Figure 46. Trapped queen of *Crematogaster* sp. (photo author).

Figure 47. Mature larvae and pupae of *Apodynerus* sp. (photo author).

Figure 48. Female *Parrarhynchium* sp. (photo author).

Figure 49. Nest of *Pararrhynchium* sp. at opening (photo author).

Figure 50. *Pararrhynchium* sp. nest on natural substrate (photo author).

Figure 51. *Pararrhynchium* sp. Prey content at opening (photo author).

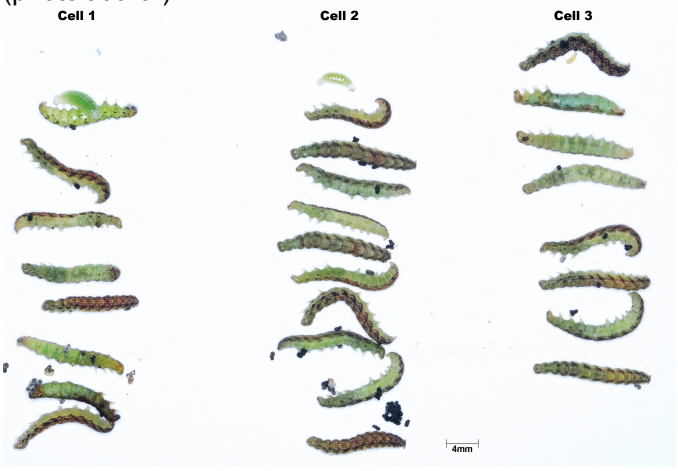


Figure 52. *Pararrhynchium* sp. Egg, mature larva and pupa (photo author).

Figure 53. Female *Pareumenes* sp**.** (photo author).

Figure 54. *Pareumenes* sp. Trap at opening (photo author).

Figure 55. Prey content of a cell of *Pareumenes* sp (photo author).

Figure 56. An egg and a mature larva of *Pareumenes* sp (photo author).

Figure 57. Female *Xenorhynchium* sp. (photo author).

Figure 58. *Xenorhynchium* sp. Content of a trap at opening (photo author).

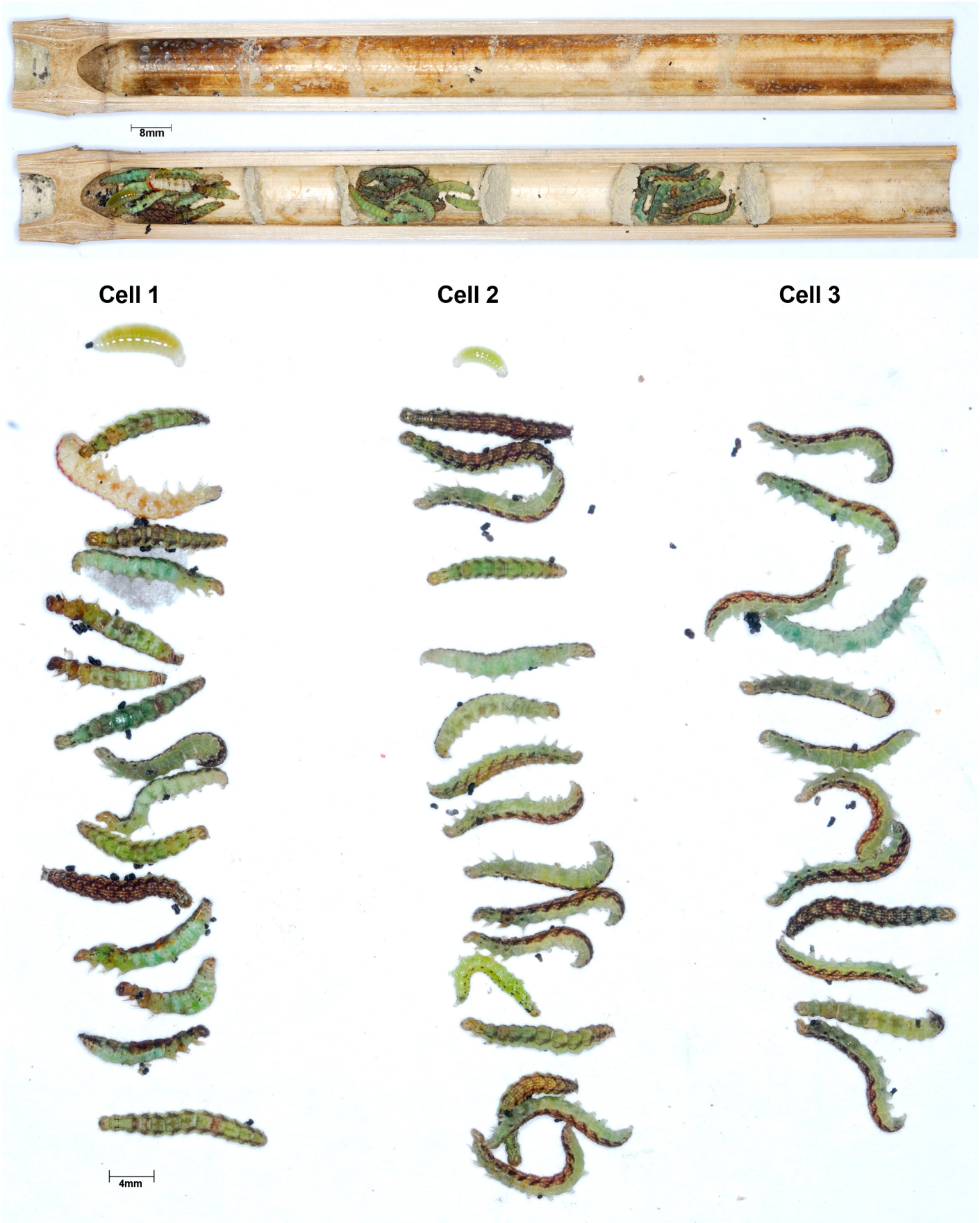


Figure 59. *Xenorhynchium* sp. An egg, a mature larva and a pupa (photo author).

Figure 60. Female *Zethus* sp constructing the entrance tunnel (photo author).

Figure 61. *Zethus* sp. Trap content at opening (photo author).

Figure 62. *Zethus* sp. Nest entrance tunnel (photo author).

Figure 63. *Zethus* sp. Egg, mature larva and pupa (photo author).

Figure 65. Female *Auplopus* sp3. (photo author).

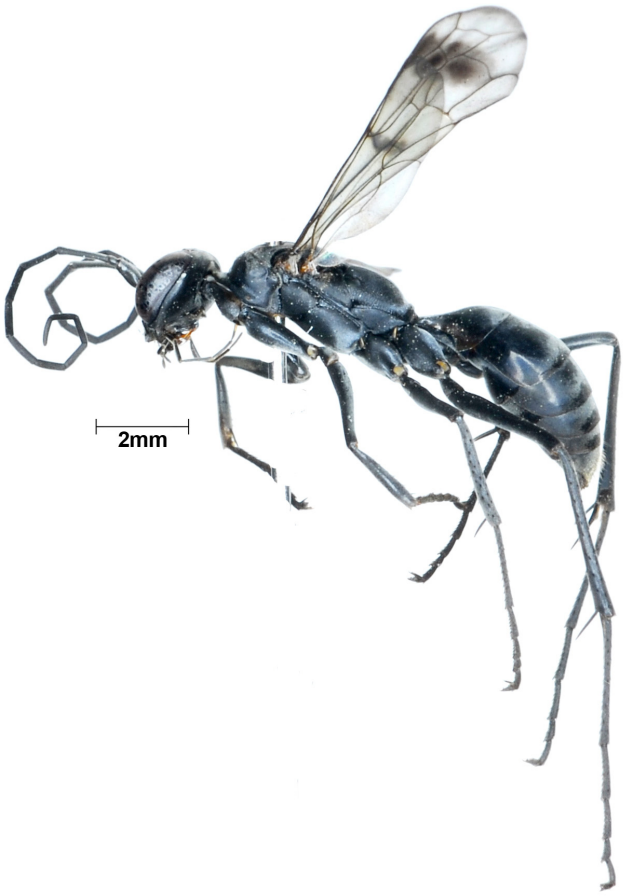


Figure 64. *Auplopus* sp2. cells (photo author).

Figure 66. Female *Chalicodoma* sp. (photo author).

Figure 69. Female *Megachile* sp1. (photo author).

Figure 67. Chalicodoma sp. Nest at opening. Note the smeared resin posteriorly, probably as an enemy repellent (photo author).

Figure 68. Egg and larva of *Chalicodoma* sp. (photo author).

Figure 70. Female *Megachile* sp2. (photo author).

Figure 71. Female *Megachile* sp3. (photo author).

Figure 74. Pollen mass mixed with nectar with mature larva of *Megachile* spp. (photo author).

Figure 72. Typical nest of *Megachile* spp. in a trap previously used by *Allorhynchium* sp. (photo author).

Figure 75. Semi-liquid food mass *Megachile* spp with egg. (photo author).

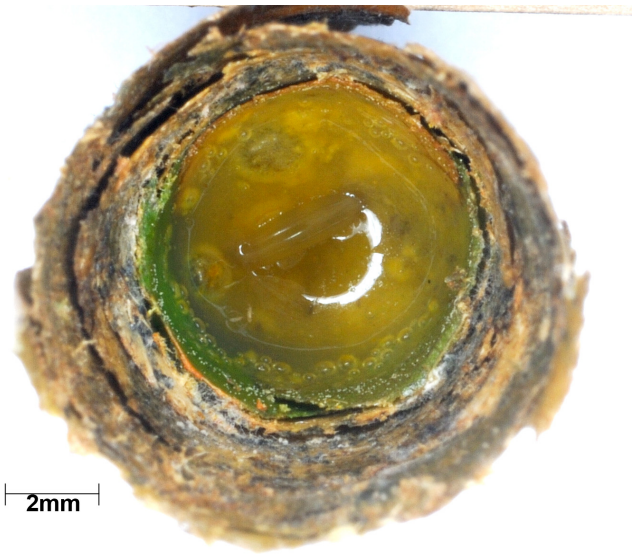


Figure 73. Nest of *Megachile* sp3. (photo author).

Figure 76. Adult *Hylaeus* sp (photo author).

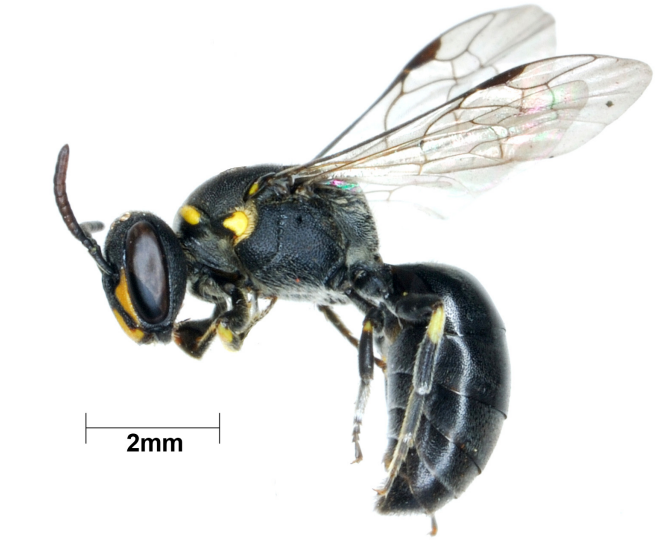


Figure 77. Cell of *Hylaeus* sp. showing the silk strands anchoring the cell to the trap walls (Photo author).

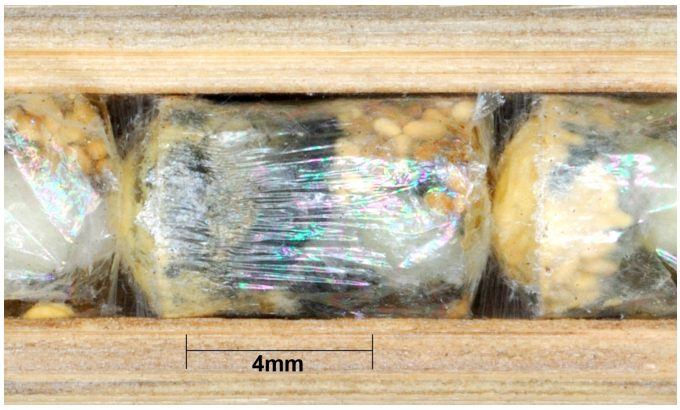


Figure 78. Nest of *Hylaeus* sp. at opening (photo author).

Figure 80. Overall statistics for the six families described

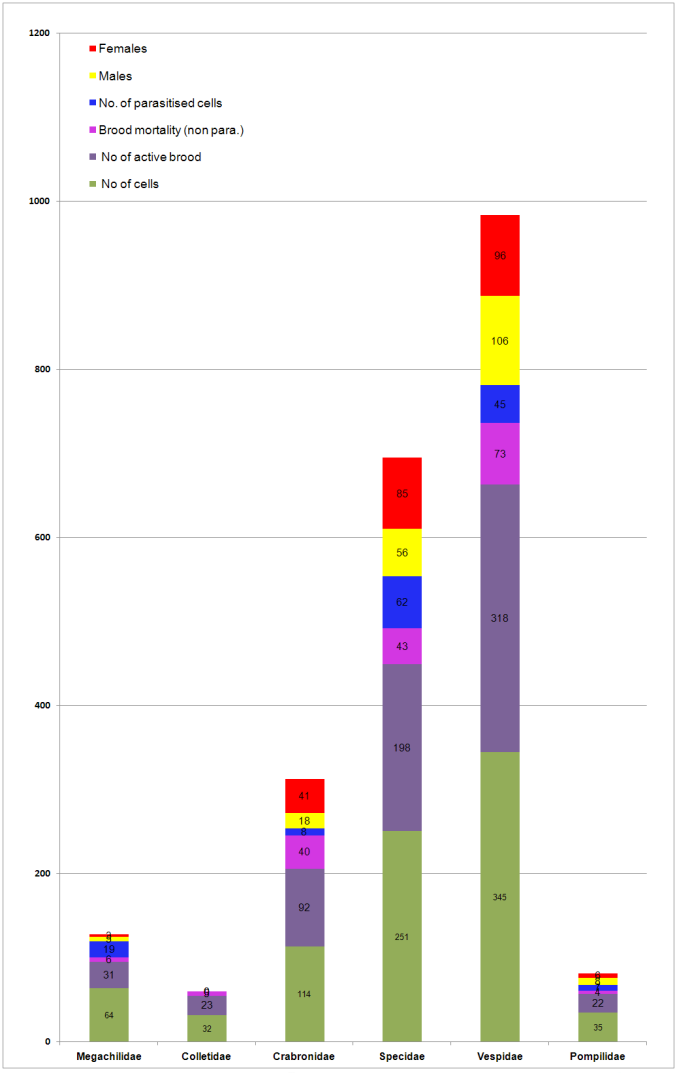
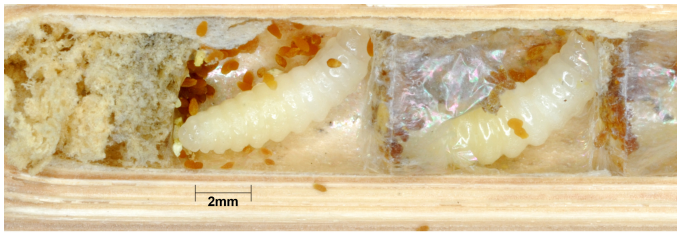


Figure 79. *Hylaeus* sp. Larvae and pupa (photo author).



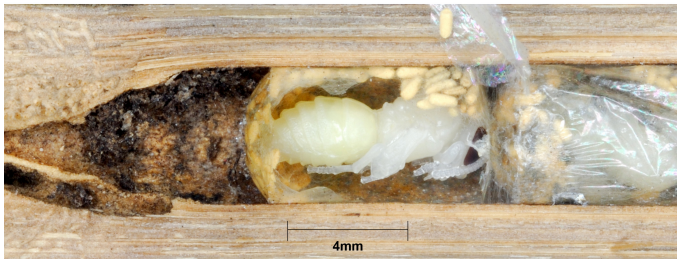


Table 1. Summary of traps content.

Species	No of cells	No of active brood	Brood mortality (non para.)	No. of parasitised cells	Females	Males
Trypoxylon formosicola	21	21	4	0	12	2
Trypoxylon petiolatum	93	71	36	8	29	16
Isodontia diodon	114	82	15	25	43	26
Isodontia nigella	13	13	3	2	2	6
Isodontia aurifrons	10	10	4	4	2	0
Chalybion japonicum	114	93	21	31	38	24
Allorhynchium sp	76	70	10	7	36	21
Anterhynchium sp	53	42	15	7	18	6
Apodynerus sp	13	12	1	0	4	5
Pararrhynchium sp	25	25	9	4	6	6
Pareumenes sp	6	6	0	0	3	1
Xenorhynchium sp	139	133	25	22	26	61
Zethus sp	33	30	13	5	3	6
Auplopus sp2	13	6	1	2	1	0
Auplopus sp3	2	2	0	0	1	1
Dipogon sp	3	3	0	0	0	2
Chalicodoma sp	33	31	2	15	2	3
Megachile spp.	31	0	4	4	1	2
Hylaeus sp	32	23	5	0	0	0
Totals	824	673	168	136	227	188

Table 2. Summary of trap architecture and prey. Data relative to *Megachile* spp. are not logged in the table because nest architecture was not ascertained for the three concerned species.

	Trap dimensions, mm				Nest Architecture					Cells dimensions														Prey	
Species	Mean Diam.	n =	Mean Length	n =	Vestibular Cell	Preliminary plug	Intercalary Cells	Bottom empty Cell	Cell partition material	Mean No. of cells/trap	n =	Mean Length Cell 1	n =	Mean Length Cell 2	n =	Mean Length Cell 3	n =	Mean Length Cell 4	n =	Mean Length Cell 5	n =	Mean Length Cell 6	n =	Mean Length Cell 7	n =	Mean No. of prey/cell	n =
Trypoxylon formosicola	5	4	171	4	N	Y	N	N	M	4.2	5	32.2	4	27.7	4	30	4	21.7	4	23.5	2	19	1	-	-	4.7	3
Trypoxylon petiolatum	7.1	17	181.4	17	Y	Y/N	N	N	M	5.5	18	22	16	18.2	16	18.9	15	23	15	20.6	12	17.7	6	18.2	5	3.9	44
Isodontia diodon	8.1	42	175.5	42	N	Y	N	Y/N	H	2.7	42	45.4	22	48.7	22	36.6	16	33.6	9	58	3	125	1	-	-	6	66
Isodontia nigella	10.7	6	241.5	6	N	N	N	N	G	2	4	73.7	4	30.7	3	22	1	-	-	-	-	-	-	-	-	7.7	4
Isodontia aurifrons	11.8	8	179	8	N	N	N	N	G	1.25	8	33.3	6	32.5	2	-	-	-	-	-	-	-	-	-	-	5	7
Chalybion japonicum	7.5	66	173	66	N	N	N	Y/N	M	1.8	66	104.3	66	44	38	39.3	11	25.5	2	-	-	-	-	-	-	11.1	52
Allorhynchium sp.	8	45	177.5	45	VC	N	N	N	R	1.7	45	68.8	41	65.7	2	32.8	5	20.9	2	-	-	-	-	-	-	PP	-
Anterhynchium sp.	8.6	20	168.3	20	Y/N	N	Y/N	N	M	2.6	20	48.7	20	35.8	20	23	10	18	4	-	-	-	-	-	-	6.5	13
Apodynerus sp.	4.8	5	169.4	5	Y/N	Y/N	Y/N	N	M	2.8	5	17.4	5	15.5	4	13	3	16	1	-	-	-	-	-	-	-	-
Pararrhynchium sp.	10.3	10	188	10	Y/N	N	Y/N	Y/N	M	2.1	9	41	8	31	4	21	2	25	1	-	-	-	-	-	-	8.3	7
Pareumenes sp.	8.7	6	181	6	Y	N	N	Y/N	M	1	6	181	6	-	-	-	-	-	-	-	-	-	-	-	-	2.5	2
Xenorhynchium sp.	9.2	53	179	53	Y/N	N	Y/N	Y/N	M	2.7	52	36	47	28.9	35	26.3	26	23.5	13	19.8	5	21.3	3	20	1	7.5	35
Zethus sp.	8.2	15	175	15	Y/N	Y/N	N	Y/N	L	2.2	15	25.3	11	49.7	8	21.5	4	22	3	22	1	-	-	-	-	12.7	5
Auplopus sp2.	11.4	4	206.2	4	-	-	-	-	M	4.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Auplopus sp3.	8	1	160	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dipogon sp.	4.5	1	140	1	-	-	-	-	M	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chalicodoma sp.	9.5	8	174.4	8	N	N	N	Y	MR	3	8	11.8	7	12.8	6	14	4	12	2	11.5	2	-	-	-	-	PO	-
Hylaeus sp.	5.1	4	165.8	4	Y/N	N	N	N	C	8	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PO	-

Notes:

N stands for No; **Y** stands for Yes; **Y/N** stands for nest that could have or not have the said parameter; **VC** stands for Vestibular chamber; **M** stands for mud/clay partitions; **MR** stands for mud/clay construction with an added layer of resin; **H** stands for plant Hairs; **G** stands for Grass; **R** stands for Resin/Plant Gum; **C** stands for Cellophane like material; **PP** stands for Progressive Provisioning; **PO** stands for Pollen

Table 3. Detail of prey of *Trypoxylon petiolatum* in four traps.

			Salticidae							Oxypodidae
Trap ref.	No. of cells	No. of Prey	*Epocilla calcarata*	*Chrysilla versicolor*	*Carrhotus sannio*	*Rhene flavigera*	*Cytaea sp1*	*Salticidae sp1*	*Salticidae sp2*	*Oxypodidae sp1*
PSO-046.A3	5	25	1	0	1	2	0	6	7	8
PSO-046.A4	5	19	9	1	1	1	1	3	0	3
PSO-046.A6	4	18	4	0	2	0	0	2	3	7
PSO-046.A7	2	7	0	0	0	0	0	6	0	1
Totals	16	69	14	1	4	3	1	17	10	19
Percentage		100.00	20.29	1.45	5.80	4.35	1.45	24.64	14.49	27.54
							Total percentage Salticidae		72.46	

Description of male and egg of *Sosibia truncata* Chen & Chen, 2000 (Phasmida: Diapheromeridae: Necrosciinae).

George Ho Wai-chun, Kowloon, Hong Kong.
Email: georgehwc@hotmail.com

ABSTRACT

Male and egg of *Sosibia truncata* Chen & Chen, 2000 are described and illustrated for the first time.

Key Words: Necrosciinae, *Sosibia truncata*, male, egg, Hong Kong, China

INTRODUCTION

The genus *Sosibia* Stål, 1875 contains 33 valid species and is restricted to the Oriental region (Brock, Phasmida Species File online). In China, six species are recognized and most of the species are solely described from one male or one female (Hennemann *et al.*, 2008; Chen & He, 2008). The Chinese representatives of the genus are still poorly known and require further research.

In southern China, *Sosibia truncata* Chen & Chen, 2000 is distributed over Hong Kong and Guangdong Province, China (Chen and Chen, 2000; Hennemann *et al*., 2008; Chen and He, 2008) and only females are known so far. The author recently conducted a survey to research the phasmid fauna of Hong Kong, and males of *Sosibia truncata* were found. In the recent monograph by Chen and He (2008), a key to the males of *Sosibia* Stål is provided including the male of *Sosibia truncata*, however, it has never been formally described. Therefore, to enrich our knowledge of the species, I describe and illustrate here for the first time males of *Sosibia truncata* along with eggs obtained from a reared female.

METHOD

The male description is based on the materials collected from Hong Kong (New Territories, Hong Kong Island and Lantau Island) and Guangdong Province (Heishiding, located at the northwestern part of Guangdong), China. The egg description is based on the eggs laid by an adult female reared in captivity and was collected from Sunset Peak, Lantau North Country Park, Hong Kong (300–400 meters above sea level). Measurements are given in mm.

The examined holotype of *Sosibia truncata* is deposited in the Institute of Entomology, Sun Yat-sen University (Zhongshan University), Guangzhou, Guangdong, China (ZSU). The non-type materials mentioned in this study are deposited in Kadoorie Farm and Botanic Garden, Hong Kong (KFBG), Institute of Entomology, Sun Yat-sen University (Zhongshan University), Guangzhou, Guangdong, China (ZSU) and the private collection of George, W.C. Ho, Hong Kong (GH).

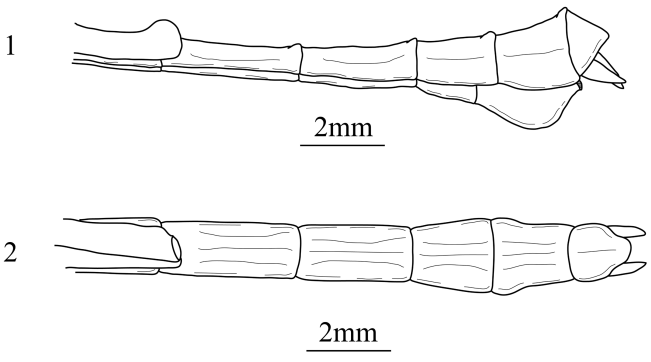
RESULTS

Sosibia truncata Chen & Chen, 2000

Sosibia truncata, Chen & Chen, 2000: 121, figs. 2a–b. Holotype: Female, Dadongshan, Lianzhou, Guangdong Province, China, 14.VII.1992, Zhuang Meibao (ZSU).
Otte & Brock, 2005: 324.
Hennemann, Conle & Zhang, 2008: 40.
Chen & He, 2008: 195, figs. 160a–c.

Other material examined: Female, Tai Po Kau, Hong Kong, China, 2007, Ho, G.W.C (GH); Female, Tai Tung Shan, Hong Kong, China, 2008, Ho, G.W.C (GH); Female, Tai Po Kau, Hong Kong, China, 19.VI.2008, Ho, G.W.C (GH); 3B&, Mt. Paker, Hong Kong, China, 27.VI.2008, Ho, G.W.C (GH & ZSU); Female & Male & 20 eggs, Sunset Peak, Lantau North Country Park, Hong Kong, 30.VI.2008, Ho, G.W.C (GH & ZSU); Male, Ng Tung Chai, Hong Kong, China, 20.IX.2008, Ho, G.W.C (GH); Female, Kap Lung, Hong Kong, China, 25.IX.2008, Ho, G.W.C (GH); Female & Male, Kowloon Peak, Hong Kong, China, 31.X.2008, Ho, G.W.C (GH); Female, Mui Sze Lam, Hong Kong, China, 31.X.2008, Ho, G.W.C (GH); Male, Pat Sin Leng, Hong Kong, China, 18.VI.2009, Ho, G.W.C (KFBG); Male, Kai Kung Shan, Sai Kung, Hong Kong, China, 25.VI.2009, Ho, G.W.C (GH); Male, Tei Tong Chai, Lantau Island, Hong Kong, China, 4.VII.2009, Ho, G.W.C (GH); 2 males & females, Heishiding, Fengkai, Guangdong Province, China, 25–27.VII.2011, Ho, G.W.C. (GH).

Description of male (Figs. 1–3): Similar to female but smaller. Body slender and slim, brown, covered with setae particularly dense on legs, less on thorax and abdomen.



Figs. 1 & 2: Male *Sosibia truncata*. 1. End of abdomen, lateral view. 2. End of abdomen, dorsal view. (Drawings by author).

Fig.3: Adult male *Sosibia truncata* (Photo by author).

Head: Flat and small, oblong, longer than wide. Eyes oval, protruding, about as long as the length of first antennal segment. Occiput flat with granules. Median furrow distinct. Antennae light brown, longer than fore legs, reaching to the sixth abdominal tergum; the first segment broader and flatter than the second segment; the second segment cylindrical, shorter than the first segment; the third to sixth segments equal in length; seventh segment and subsequent segments are slender and indistinct.

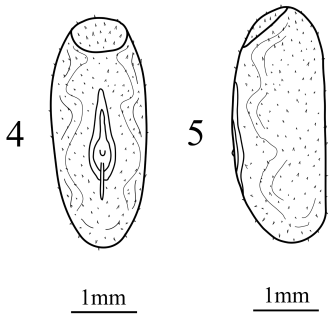
Thorax: Pronotum two times longer than wide, anterior margin curved inward, with a transversal and longitudinal sulcus, the longitudinal sulcus projecting to the end of hind margin of pronotum, with granules. Mesonotum with distinct median longitudinal carina, as long as the profemora, covered with irregular sized granules, expanded behind. Combined length of metanotum and median segment longer than head and pronotum together.

Abdomen: Rather slender, longer than the head and thorax together. Median segment nearly as long as metanotum. The longest segment being the second tergum, the third to sixth tergites are similar in length, the seventh tergum shorter than the proceeding tergites, the eighth tergum widened posteriorly, the shortest segments being the ninth and anal segments. The seventh, eighth and ninth tergites with obvious median longitudinal and lateral carinae but smooth from second to sixth tergites. Sixth to ninth tergites with a small hump medio-posteriorly. The hind margin of the anal segment protruding and rounded. Poculum projecting beyond the hind margin of ninth tergum. Cerci long and straight with setae, exceeding the anal segment, broader at base, apex acute and slightly curved inward.

Legs: Brown, same as thorax, with black markings and dense setae. Hind legs longer than fore legs and longer than mid legs, nearly reaching to the tip of abdomen. Mid legs obviously longer than head, pronotum and mesonotum together. Profemora curved basally.

Wings: Tegmina short and brown, as long as pronotum, the elevated portion is black and blunt. Alae long, projecting beyond the sixth tergum, red at base, costal region brown and anal region uniformly gray. Apex of alae rolled up and black.

Description of egg (Figs. 4–5): The capsule is oval and light brown with white marks. Densely covered with spine-like bristles. Ventral surface grey and smooth. Operculum flat, also sparsely covered with spine-like bristles. Micropylar plate oblong, rounded at posterior end and slightly pointed at anterior end. Median line about one-third of the length of micropylar plate. Micropylar cup white and placed near the anterior end of the median line. The eggs were randomly glued to the rearing cage and on leaves of food plants. Length 3.2 mm, width 1.7 mm, height 2 mm. The measurement of the male is given in Table 1.



Figs. 4 & 5: Egg of *Sosibia truncata*. 4. Dorsal view. 5. Lateral view. (Drawing by author).

Distribution: In Hong Kong, *Sosibia truncata* is uncommonly found in mature woodland in New Territories, Hong Kong Island and Lantau Island. In China, it is only known from Guangdong Province.

Body part	Length, mm	Mean, mm	*n* =
Body	48–52	50.8	6
Head	2.5–2.7	2.5	6
Antennae	31–33	32	5
Pronotum	2.5–3.1	2.9	6
Mesonotum	9–10	9.6	6
Metanotum including median segment	6–7	6.25	6
Profemora	9–11	9.7	6
Mesofemora	7.5–8	7.7	6
Metafemora	11–13	11.7	6
Protibiae	8–9	8.25	6
Mesotibiae	5.5–7	6.2	6
Metatibiae	10.5–12	11.3	6
Tegmina	2–3	2.5	6
Alae	21.5–24	22.1	6

Table 1. Measurements of male *Sosibia truncata* Chen & Chen, 2000

ACKNOWLEDGMENT

The author would like to deeply thank Dr. Philip Bragg, United Kingdom for commenting on a draft of this article. The author also wishes to thank Prof. Pang Hong, Dr. Zhang Binglan, and Mr. Xie Weicai, Research Institute of Entomology, Zhongshan University, Guangdong Province, China, Dr. Roger Kendrick, Kadoorie Farm and Botanic Garden, Hong Kong, Mr. Wong Koon Wang, and Mr. Cheung Ka Shing, both from the Agriculture, Fisheries and Conservation Department, Hong Kong for their kind assistance.

REFERENCES

Brock, P.D. *Phasmida Species File Online*. Version 2.1/ 4.0. [7th January 2012]. Downloaded from: <http:// Phasmida.SpeciesFile.org>.

Chen, S.C. & Chen, Z. 2000. Two new species of the genus *Sosibia* from Guangdong province, China (Phasmatodea: Heteronemiidae). *Acta Scientiarum Naturalium Universitatis Sunyatseni* 39(1): 121–122.

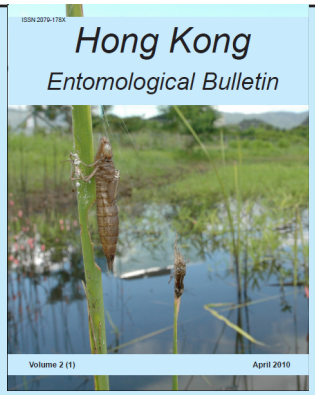
Chen, S.C. & He, Y.H. 2008. *Phasmatodea of China*. Science Press, China. 476pp.

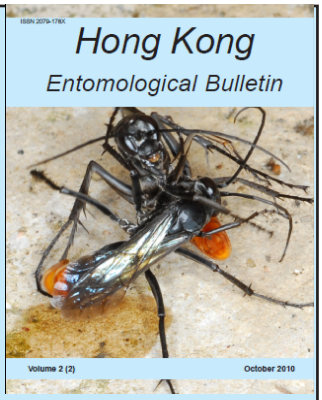
Hennemann, F.H., Conle, O.V. and Zhang, W.W. 2008. Catalogue of the Stick and Leaf-insects (Phasmatodea) of China, with a faunistic analysis, review of recent ecological and biological studies and bibliography (Insecta: Orthoptera: Phasmatodea). *Zootaxa* 1735: 1–76.

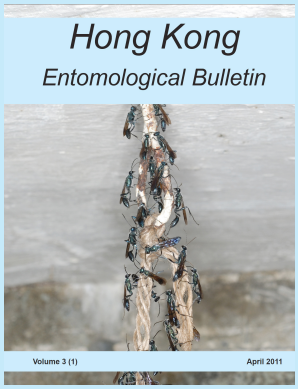
Otte, D. & Brock, P.D. 2005. *Phasmida Species File - Catalog of stick and leaf insects of the world*. The Insect Diversity Association and the Academy of Natural Sciences, Philadelphia. 414pp.

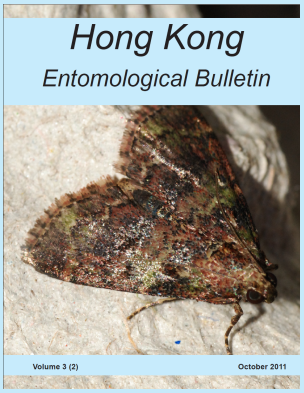

香港昆蟲報
Hong Kong Entomological Bulletin
Volume 1, Issue no. 1
April 2009
ISSN 2079-178X
Contents
01
14
18
23
38
香港昆虫学会
Hong Kong Entomological Society
www.hkentsoc.org
contact@hkentsoc.org
Editors
Graham Rees
Christopher Reid
Paul ASTON
Ho YIU
Design & Page-setting
Chiu Ka YIP
©All rights reserved.


香港昆蟲報
Hong Kong Entomological Bulletin
Volume 1, Issue no. 2
November 2009
ISSN 2079-178X
Contents
02
06
26
32
38
香港昆虫学会
Hong Kong Entomological Society
www.hkentsoc.org
editor@hkentsoc.org
Editors
Graham Rees
Christopher Reid
Design & Page-setting
Chiu Ka YIP
©All rights reserved.


ISSN 2079-178X
Hong Kong
Entomological Bulletin
Volume 2 (1)
April 2010


ISSN 2079-178X
Hong Kong
Entomological Bulletin
Volume 2 (2)
October 2010


Hong Kong
Entomological Bulletin
Volume 3 (1)
April 2011


Hong Kong
Entomological Bulletin
Volume 3 (2)
October 2011